# Essays in Organizational and Personnel Economics

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The Faculty of Economics, Business Administration and Information Technology of the University of Zurich hereby authorises the printing of this Doctoral Thesis, without thereby giving any opinion on the views contained therein.

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During my undergraduate studies of economics at the University of Mannheim, I have been puzzled by the lack of integration of psychological insights into the field of economics. While I understood the advantages of a simple and parsimoneous approach towards the understanding of human behavior, the standard economic model that exclusively focussed on own payoffs and extrinsic forms of motivation has never fully convinced me. During my studies abroad at the University of California in Berkeley, I was fortunate to take classes with some of the greatest teachers of economics. George Akerlof opened up new horizons by showing me how psychology and sociology can be integrated into macroeconomic models. Botond Koszegi taught me how psychology informs economics and how the two disciplines can be linked to each other, and Teck-Hua Ho and Shachar Kariv introduced me to the power of economic experiments as an empirical method for testing economic theory. During my stay in Berkeley and thanks to the abovementioned professors, I developed a strong passion for behavioral and experimental economics and came to the conviction to pursue research in precisely this field.

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# INTRODUCTION

The standard economic approach to study human behavior is based on the assumption that humans are rational actors who always behave in a utility maximizing fashion. Utility is usually represented in mathematical terms, which allows to make unambiguous predictions with regard to behavior that are empirically falsifiable. However, the approach has its obvious limitations because models of economic behavior have to remain mathematically manageable. The prerequisite of mathematical tractability has constrained economists to keep models of human decision making fairly simple, which inescapably lead to a model of human decision making that is based on oversimplified assumptions. The usual defense of economists to this kind of criticism is that economics is not primarily interested in getting the assumptions of the model right, but in making correct predictions about behavior. Hence, economists built so called "as-if" models, which need not be based on correct assumptions as long as the model predictions are correct. The beauty of tractable mathematical modeling of human utility came at the cost of increasingly accepting a potentially oversimplified model of human behavior, whose underlying assumptions were no longer questioned within the profession.

Some decades ago, however, the as-if modelling approach as well as the then widely accepted model of human behavior came under scrutiny from a handful of researchers, most prominently Amos Tversky, Daniel Kahneman, Richard Thaler and George Akerlof, who became increasingly dissatisfied with this reduced approach to modeling human behavior. They believed that improving the realism of assumptions in economic models will lead to better model predictions and postulated that important insights from psychology as well as sociology should be integrated into economics. Since then, a research stream called behavioral economics has become increasingly popular and proven influential within the economics discipline.

The goal of behavioral economics is to improve the predictions of economic

models by supplying a more realistic and psychologically informed foundation of human decision making. One strand of behavioral economics systematically analyzes the circumstances under which the standard economic model delivers systematically wrong predictions, and tries to improve upon the assumptions underlying economic models. A second strand tries to integrate these novel insights into economic models while maintaining the beauty of the mathematical approach, the property that utility can be represented by a mathematical objective function. Hence, behavioral economists try to advance the understanding of what governs human decision making. An important example of such an advancement is Kahneman and Tversky (1979), wo have proposed prospect theory and loss aversion as an alternative model of human behavior under risk, that challenged the widely excepted benchmark that humans maximize expected utility, a theory that has been proposed by von Neumann and Morgenstern (1944). Similarly, Fehr and Schmidt (1999) have been influential in introducing social comparisons into the utility function, an approach that has proven to be successful in better explaining behavior than the standard assumption of purely selfish motivation in a large variety of domains. A third famous example of how behavioral economics was influential in changing the way economists think about human decision making is hyperbolic discounting (Laibson, 1997), which challenged the prevailing assumption that humans make time consistent choices and consumption- and savings plans.

This thesis contributes to the advancement of behavioral economics by applying behavioral economics to organizations. Organizations have received increased attention from behavioral economists in recent years (Camerer and Malmendier, 2007). Organizational economics is concerned with the study of the inner workings and the efficiency of organizations as well as the boundaries of the firm based on economic principles. Every party within the organization is modeled as an independent agent who maximizes his utility conditional upon constraints that are due to organizational structure and contracts. For a long time, this literature has ignored psychological factors that may influence behavior within organizations. However, this has changed in recent years due to difficulties of the standard approach in explaining observed behavior and contracts in organizations. For example, there is now increasing evidence that fairness concerns and entitlements that stem from contractual agreements can have significant effects on behavior that cannot be explained by the standard economic model (Hart and Moore, 2008; Fehr,

Hart, and Zehnder, forthcoming).

A major obstacle for progress in the field of organizational economics has been the poor availability of data that would allow rigorous testing of organizational economic theory. Within-firm data is hard to acquire, and it often lacks sufficient information to perform rigorous empirical tests of theory. Because of these difficulties, experimental methods have become increasingly popular to provide empirical evidence on economic models of organizations (Camerer and Weber, forthcoming). Experimental methods give the experimenter control over relevant parameters and allow the experimenter to directly observe decisions. An experiment therefore consitutes an ideal environment for rigorous testing of theory.

In this thesis, I derive hypotheses with regard to organizational behavior that are motivated from insights in economics as well as in the psychology and political science literatures, and I use experimental methods to provide empirical evidence. The focus of the first two chapters is on the effects of power (or authority, as I will call it most of the time in the context of organizations) on behavior and motivation. The assignment of authority and the resulting organizational hierarchy is an important aspect of incentive provision within organizations. Because in organizations contracts are often incomplete, the organizational hierarchy has major implications for individual incentives (Aghion and Tirole, 1997). Understanding whether the assignment of authority as a channel of incentive provision is used effectively or whether there are frictions which may interfere with the evolvement of optimal organizational structure in unfavorable ways is therefore important. Indeed, evidence from psychology and the political sciences suggests that power may influence human behavior beyond the pure incentive effects that arise due to the authority structure within the organization. The psychological effects of power on behavior may be manifold. Deci (1981), Bandura (1997) and McClelland (1975) suggest that humans have an intrinsic value for power, and Anderson, Gruenfeld, and Keltner (2003) argue that power has consequences on human motivation that are independent of the pure incentive effects of power. This view on power is also reflected in the political science literature (Lukes, 2005). Since these motivational aspects of power may interfere with effective organizational structures in many ways, it is important for economists to understand the motivation and incentive effects of power more thoroughly and incorporate potential psychological effects of power on utility and behavior in models of organizations. This thesis aims to

provide a step in this direction.

Chapter 1 experimentally analyzes the willingness of principals to delegate authority, and the effects of authority on effort provision. We find that principals often keep authority even when it is in their material interest to delegate authority to an agent. We find that this behavior can cause large organizational inefficiencies, and conjecture that subjects may have an intrinsic value of authority. In addition, we observe that individuals who have authority frequently over-invest, and when they lack authority they frequently under-invest in effort. This suggests a motivating effect of having, respectively a de-motivating effect of not having authority.

In Chapter 2, we are interested in directly testing the hypothesis that individuals intrinsically value authority. While our evidence in Chapter 1 strongly suggested such a result, the evidence was not conclusive. In Chapter 2, the experimental design strictly controls for the monetary consequences of the authority allocation, as well as for risk-, ambiguity- and social preferences. We find that principals demand a significant compensation for the loss of authority that must be due to an intrinsic value of authority.

Chapter 1 and Chapter 2 show the existence of a preference for authority that can interfere with the evolvement of optimal organizational structure in multiple ways. Our findings give a rationale for empire building, they provide insights why mergers and acquisitions can fail despite the existence of large organizational synergies, they provide evidence in favour of psychological benefits of control rights and they help to better understand the channels through which organizations can use authority as an empowerment device to motivate agents.

The third chapter of this dissertation applies insights from behavioral economics to innovation. Innovation is central to organizational success and economic growth. Nonetheless, little is known theoretically as well as empirically about the individual determinants of innovative activity. The focus of the third chapter is on the interaction of a particular psychological bias, judgemental overconfidence, with innovative activity. We develop a theoretical framework that suggests that judgmental overconfidence, the tendency to overestimate the precision of one's own information, is detrimental to innovative activity, and provide experimental evidence in favor of this hypothesis. The second main contribution of the paper is the provision of evidence on the external validity of experimental measures of innovative activity. Having experimental tools to measure innovative activity is desirable

because the impact of institutions, incentives and market conditions on innovative outcomes is still poorly understood. The advantage of experiments is that they enable researchers to identify ceteris paribus effects in a controlled environment. We use a pool of managers in a financial industry firm to combine experimental measures with external on-the-job data. We find that performance in our experimental task is strongly correlated with innovativeness and creativity ratings in the company. The insight that judgemental overconfidence can be detrimental to innovative activity has important implications for optimal research and development policies within organizations. A key insight of the theory and empirical evidence is that the creative phase of the innovative process tends to be too short due to overconfidence. Making researchers aware of this bias and policies that externally prolong the creative phase within the innovative process may therefore improve innovative outcomes and foster economic and organizational growth.

# 1. THE LURE OF AUTHORITY: MOTIVATION AND INCENTIVE EFFECTS OF POWER

## *Chapter Overview*

Authority and power permeate political, social, and economic life but there is limited empirical knowledge about the motivational origins and consequences of authority. We experimentally study the motivation and incentive effects of authority in an authority-delegation game. Individuals exhibit a strong tendency to retain authority even when its delegation is in their material interest — suggesting that they value authority per se. Moreover, this tendency to hold on to authority strongly increases with individuals' degree of loss aversion, suggesting an endowment effect with regard to authority. Authority also leads to a substantial over provision of effort by the controlling party, while a large percentage of subordinates under provide effort despite pecuniary incentives to the contrary. Thus, authority has important motivational consequences that exacerbate the inefficiencies arising from suboptimal delegation choices.

## *1.1 Introduction*

Authority and power play an important role in human societies. Influential scholars from various social science disciplines — such as Marx (1867), Russell (1938), Parsons (1963), Dahl (1957), and Weber (1978) — have contributed to our understanding of the origins, characteristics, and potential consequences of these forces.

Despite some notable early exceptions (Simon (1951); Zeuthen (1968); Harsanyi (1978); Bowles and Gintis (1988)), the study of authority and power has not been a major focus in economics. More recently, however, organizational economists have taken interest in the incentive effects of decision rights by studying situations in which one party has the contractual right to make decisions that influence the payoffs and potential choices of another (Grossman and Hart (1986); Hart and Moore (1990); Aghion and Tirole (1997); Baker, Gibbons, and Murphy (1999); Dessein (2002); Aghion, Dewatripont, and Rey (2004)). By granting decision rights, inefficiencies can be eliminated by shielding the controlling party from potential holdup and expropriation.

There is, however, very little *empirical* work in economics that examines the behavioral consequences of authority and power or their motivational origins. This paper explores these forces using a laboratory experiment in which we study how individuals manage and respond to authority in a hierarchical relationship. We propose a new "authority-delegation game" based on the model of authority developed in Aghion and Tirole (1997). A principal and an agent must select one of a large number of potential projects for implementation. One party, initially the principal, has authority which implies that she has the right to decide which project to implement. The other party, initially the agent, can only make a project recommendation but lacks direct power to determine the project.

Payoffs to the principal and agent for implementing a project are unknown *ex ante* and both parties can provide effort which directly controls the probability with which they learn the value of each project. One of the projects is best for the principal, while a different project is best for the agent. Relative to first best, this conflict of interest leads to under provision of effort by the agent since his suggestions may be overruled when both parties are informed.

Before the parties provide effort, the principal can delegate authority to the

agent and become the subordinate party. Delegation of authority means that the agent becomes the controlling party and has the right to choose the project. Delegation increases the agent's effort because he can now implement his preferred project in cases where he is informed. However, delegation also reduces the principal's control over project choice. When the principal's return from the agent's preferred project is high, the cost of losing authority is small. A rational principal who maximizes his expected payoff should thus delegate authority in these cases. When a principal's return from the agent's preferred project is low, however, the cost of losing authority is high and a rational, expected payoff maximizing principal should retain authority.

This setting neatly captures the notion of power as defined by Max Weber.[1] According to Weber an actor has power in a social relationship if he "is in the position to carry out his own will despite resistance" (Weber (1978, p. 53)). In the setting of Aghion and Tirole (1997), the controlling party — which is the agent in the case of delegation, and the principal in the case of retention — has power over the subordinate party because the controlling party can overrule the subordinate party's project preference. In the experiment, we find that the controlling parties use their power extensively. If they are informed about the project valuations they almost always overrule the subordinate's recommendation.

Our first main result is that the principals show a strong preference for retaining authority in situations in which they could substantially improve their expected income by delegating authority to the agents. More specifically, rational principals who maximize their expected income should delegate authority in those treatments where the principal's return from the agent's preferred project is relatively high. However they only do so in roughly 40 percent of these cases. Pessimistic expectations about the agent's effort in case of delegation cannot explain this reluctance. On the contrary, the principals have quite reasonable beliefs about the agent's effort, meaning that it would be profitable to delegate in the clear majority of cases based on these beliefs. Nevertheless, principals prefer to keep authority.

[1] We view authority as a form of power in which the controlling party has the right to make decisions which directly affect the payoffs of another individual who has no means of successfully resisting the controlling party's decision. Aghion and Tirole used the term "authority" to describe the hierarchical relationship between the controlling and the subordinate party, but the relation between the two parties can also be characterized as a power relationship in Max Weber's sense.

These findings suggest that the principals might view authority not just as an instrument that helps them increase their earnings, but that they value the decision right (i.e. authority) per se. Several psychologists have postulated a preference for power (McClelland (1975), Mulder (1975), Poppe (2003)) or a preference for agency, autonomy and self determination (Rotter (1966); deCharms (1968); Deci (1981); van Dijk and Poppe (2006)). To our knowledge, however, no evidence yet exists that proves a willingness to pay (i.e. a preference) for power, agency, or autonomy.[2] In our experiment, the fact that the principals are willing to sacrifice some of their earnings to keep authority indicates a willingness to pay for the decision right.

If it is indeed the case that decision rights are valued per se, then we might also observe an endowment effect in decision rights. There is evidence (Knetsch (1989), Kahneman, Knetsch, and Thaler (1990)) that subjects have a higher valuation for goods if they are randomly endowed with them compared to a situation in which they have to buy them. One important potential reason for the tendency to assign higher valuations to owned goods is loss aversion (Knetsch (1995)); the tendency of losses to loom larger than gains. In our experiment, the subjects were randomly assigned the role of the principal, i.e. principals were randomly endowed with decision rights. Thus, if there is an endowment effect in decision rights, then those principals who are more loss averse should show a greater reluctance to delegate authority. We indeed find that loss aversion has a large and significant effect on subjects' reluctance to delegate. Subjects with a degree of loss aversion above the median are 20 percentage points less likely to delegate than those with below-median loss aversion. Moreover, subjects assigned to the principal's role expressed a much stronger preference for the role of the controlling party in an exit survey after the experiment than subjects who were assigned to the role of the agent. Thus, despite the fact that the principals earned less money during the experiment when they were the controlling party, the large majority of the principals expressed a

[2] A preference for power can explain why principals hesitate to delegate authority. Also, being subject to the choice of a controlling party may be viewed as a constraint on autonomy; if the principal values autonomy positively, he has a reason to avoid delegation. Interestingly, Adam Smith stipulated the existence of a preference for "domination and authority" in his lectures on jurisprudence (Smith, 1978, p. 186): "yet the love of domination and authority and the pleasure men take in having every<thing> done by their express orders, rather than to condescend to bargain and treat with those whom they look upon as their inferiors and are inclined to use in a haughty way; this love of domination and tyrannizing, I say, will make it impossible for slaves in a free country ever to recover their liberty". We owe this reference to John Elster.

preference for being the controlling party.

Our second main finding is that the controlling party substantially over provides effort relative to the Nash equilibrium and relative to his best response to the subordinate party's anticipated effort. We show that loss aversion cannot explain this behavior. Furthermore, neither deviations from risk neutrality nor social preferences can explain the controlling party's excess effort. It thus seems that the mere fact of having authority has strong motivational effects on effort choices.

Our third main finding is that, relative to the Nash equilibrium, subordinates substantially under provide effort. In fact, a substantial minority of the subordinate parties (between 30 percent and 50 percent across various conditions) choose a zero effort level even though — due to the very small cost of low positive effort levels — zero effort is almost never an optimal choice. This result suggests that the lack of authority has a strong demotivating effect on a substantial minority of the subordinate parties.

Our paper is related to the experimental literature on the consequences of delegation on punishment choices (Bartling and Fischbacher (2008), Coffman (2010)), the willingness to behave selfishly (Weber, Hamman, and Loewenstein (2010)), on public goods provision (Weber, Hamman, and Woon (2010)) and on the hidden costs of control (e.g. Falk and Kosfeld (2006), Charness, Cobo-Reyes, Jimenez, Lacomba, and Lagos (2009)). However, none of these papers examines and identifies the reluctance to delegate in the context of the optimal allocation of decision rights.

We believe that our results have potentially important implications across many domains. In relation to the property rights literature (Grossman and Hart (1986); Hart and Moore (1990)), if people value decision rights per se, it may be difficult to (re)allocate authority in organizational hierarchies to the benefit of the organization because even if organization members with authority would benefit economically from delegation, they may oppose it. In one of our treatments, the under delegation of authority not only reduces the principals' earnings, but also causes the agent to lose money. Thus the distortion in the allocation of control rights can lead to organizational structures that reduce the value of the organization as a whole. The identification of motivational obstacles to delegation adds an important component to the theoretical work by Baker, Gibbons, and Murphy (1999), Sliwka (2001), and Bester and Krahmer (2008) which predicts limits to delegation in environments with limited commitment, dynamic incentives, or limited liability.

A reluctance to delegate power may also play a role in both corporate finance and the political sphere. Models of empire-building investment (Jensen (1986), Hart and Moore (1995)) which have been used extensively in the literature to understand the trade-offs between financial instruments may, in part, be founded on a desire for power. Similarly, the taste for power may provide a rationale for term limits because otherwise politicians may try to keep their political power positions beyond what is good for the polity. In addition, the desire for power may also provide a rationale for models in the spirit of Niskanen (1971) which assume that bureaucrats seek to maximize their discretionary budget.

The motivational consequences of authority for effort provision may be equally important. The motivation enhancing effect for the controlling parties and the detrimental effect on the motivation of a large minority of the subordinates suggest that the incentive effects of authority are much larger than the standard model predicts; a reallocation of authority causes much larger effort increases for the new controlling parties and may cause a much larger effort reduction for the previously controlling party. The noteworthy gap between the controlling and the subordinate parties' efforts also implies that the efficiency costs of authority are likely to be higher than predicted by the standard model, as, in the presence of strictly convex (and identical) effort cost functions, the first best effort allocation requires effort to be identical across parties. Additionally, the result that a lack of authority only seems to demotivate a minority of people strongly suggests that putting the right people into positions that lack authority is important.[3] The development of tools for detecting this type of employee may thus be important in minimizing the cost associated with the (re)allocation of authority.

Our results on effort behavior are related to the psychological literature on the consequences of power (Anderson and Berdahl (2002); Anderson, Gruenfeld, and Keltner (2003); Anderson and Galinsky (2006)). These studies put forward the hypothesis that power induces approach-related behaviors while lack of power causes inhibition-related behaviors. According to this view, approach-related behaviors focus on potential gains in risky situations, while inhibition-related behaviors focus on the downside risk. In our setting, this hypothesis implies that the

[3] We find strong evidence that the vast majority of subordinates consists of two types. Most subordinates display either persistent underprovision or persistent overprovision of effort relative to the best reply.

controlling party is strongly focused on the large payoff that accrues if the party can choose the preferred project. The controlling party will thus tend to provide a high effort in order to make sure that the preferred project can be identified. In contrast, the subordinate party focuses on the worst case, given by a high effort and a complete lack of information about which projects yield a positive return.[4] By reducing the effort to very low levels, the subordinate can improve the payoff in this worst case, which may provide a reason for many subordinates' low effort levels. Our effort pattern is thus compatible with this approach/inhibition hypothesis, but we also believe that more research is needed to identify the motivational forces behind the effort choices more precisely.[5]

Despite the systematic deviations from the predictions of the Aghion and Tirole (1997) model, we believe that their model is very useful for the study of authority, because the main comparative static predictions of the model are nicely met and the precise numerical predictions of the model enabled us to detect the motivational forces we described above. The model is thus incomplete in terms of the underlying motivational forces, but the (incomplete) model is remarkably robust in terms of the comparative static predictions. It remains to be seen whether this robustness is a general feature of the broader organizational economics literature where communication (Rantakari (2008), Dessein (2002)), monetary incentives (Athey and Roberts (2001)), and dynamic learning (Aghion, Dewatripont, and Rey (2004)) are possible. However, even if the robustness of the comparative static predictions of the Aghion and Tirole model extends to the broader organizational economics literature, we believe that this literature should take into account the behavioral forces observed in our paper because — as we show here — they may have important

[4] In the experiment, the party either knew the valuations of all available projects or of none. In the worst case neither the principal nor the agent knows the project valuations.

[5] The subordinates' low effort levels may, for example, also be a consequence of their distaste for the constraints on the project choice. As in Falk and Kosfeld (2006) they may react to a constraint on their action space with a reduction in effort. There is, however, a decisive difference between their result and ours. While providing the lowest feasible effort level was always in the agent's material self-interest in Falk and Kosfeld (2006), the subordinate hurts himself if he chooses a zero effort level in our setting. The principal's constraint on the agent's action space thus makes agents more selfish in Falk and Kosfeld. In our paper, the lack of authority induces the agents to make choices against their material self interest. This behavior resembles the "discouraged worker effect" which describes workers who have ceased to search for a job. Perhaps, the fact that subordinates can be overruled generates a kind of "discouraged subordinates' effect".

consequences.

The remainder of the paper is structured as follows. We present a simplified version of the model of Aghion and Tirole (1997) in section 1.2 and derive its theoretical predictions. Section 1.3 details our experimental design and hypotheses. Section 1.4 reports the main results of our experiment and is separated into three parts. Section 1.4.1 summarizes the data and provides an overview of the major results. Section 1.4.2 explores possible reasons why principals might choose to keep control rights. The third part, consisting of sections 1.4.3-1.4.5, examines the reasons for the controlling parties' over provision of effort and why subordinate parties might want to under provide effort relative to the Nash equilibrium. Section 1.5 concludes.

## *1.2 The Model*

The basis of our experimental design is a model of authority developed in Aghion and Tirole (1997). We consider a world in which a principal (she) and an agent (he) are organized in a hierarchical structure and must decide to implement one or zero project out of a set of $n \geq 3$ potential projects. With each project $k \in \{1, \ldots, n\}$, there is an associated non-contractible gain of $P_k$ for the principal and a private benefit $A_k$ for the agent. If no project is implemented, the profit and private value are both equal to a known outside value of $P_0$ and $A_0$ respectively.

For ease of exposition, we index the principal's preferred project by 1 and the agent's preferred project by 2. The principal's preferred project yields known profit $P_1$ to the principal and $A_1$ to the agent where $P_1 > P_0$ and $A_1 > A_0$. Likewise, the agent's preferred project yields known benefit $P_2$ to the principal and $A_2$ to the agent with $A_2 > A_0$ and $P_2 > P_0$. As their name would suggest, the principal's preferred project yields a strictly higher value to the principal than the agent's preferred project ($P_1 > P_2$). Likewise, the agent's preferred project yields strictly higher value to the agent than the principal's preferred project ($A_2 > A_1$).

While the potential values of projects are known, all projects look identical *ex ante* and information must be collected in order to differentiate between them. The principal and agent acquire information in a binary form. At private cost $g_A(e)$, the agent learns her payoffs to all candidate projects with probability $e$. With probability $1 - e$, the agent learns nothing and cannot differentiate between the projects.

Similarly, at private cost $g_P(E)$, the principal becomes perfectly informed about the payoffs of all projects with probability $E$ and learns nothing with probability $1 - E$. Effort choices are made simultaneously and privately. To impose a unique interior solution in the current general form, we assume that both $g_A$ and $g_P$ are strictly convex, satisfy $g_i(0) = 0$ and $g_i'(0) = 0$ for $i = A, P$ and that $A_2 - g_A(1) \leq A_0$, and $P_1 - g_P(1) \leq P_0$. These last assumptions imply that the principal and agent would rather accept the outside option with certainty than guarantee themselves their preferred project.[6]

We consider a four stage game which relates decision rights, incentive conflict, and effort. In the first stage, the principal decides whether to keep decision rights or to delegate them to the agent. In the second stage, both parties privately and simultaneously gather information about the $n$ projects' payoffs. In the third stage, the subordinate recommends a project to the controlling party. Finally, the controlling party implements a project or the outside option on the basis of his information and the information communicated by the subordinate.

We assume that the principal and agent are risk neutral. For a given effort level and implemented project, the principals utility is $P_k - g_P(E)$. The agents utility is $A_k - g_A(e)$. As the benefit to the principal is non-contractible, the introduction of wages is necessary only to satisfy the agent's participation constraint, which, to avoid further notation, we assume to be satisfied.

Information in the model is *soft* so that information passed between parties cannot be verified. As such, if one party is informed and the other party is uninformed, the informed party can limit the amount of information given to the other party. As there is always an incentive conflict between the parties and outcomes are non-contractible, there is always an incentive to restrict information to the preferred project of the informed individual. It follows that communication between parties is reduced to a recommendation for a single project choice.

Formal authority is defined as having the right to make the final decision. We analyze two cases, a P-Formal authority structure in which the principal maintains decision rights and an A-Formal authority structure in which the principal delegates decision rights to the agent. In the P-Formal case, a principal may always

[6] In the experiment, we depart from this assumption and ensure uniqueness by imposing linearity in the reaction functions.

overrule the agent. She does so if she is informed and if the agent's recommendation is not the principal's preferred project. Otherwise, she (optimally) rubberstamps the agent's proposal any time she is not informed since $P_2 > P_0$.[7] Under A-Formal authority, the principal delegates decision rights to the agent, giving him the irrevocable right to make the project choice.

### *1.2.1 Analysis and Theoretical Implications*

We denote the party that has authority as the controlling party while the party without authority is called the subordinate. For each party, the expected value for selecting a project at random is less than their respective outside option. Thus, under the assumption of risk neutrality or risk aversion, the subordinate prefers to recommend the outside option rather than a random project. Similarly, an uninformed controlling party never chooses unilaterally to undertake a project other than the outside option.

Given that $A_2 > A_1 > A_0$, $P_1 > P_2 > P_0$, and information is soft, the subordinate under both authority structures always has an incentive to recommend his or her preferred project to the controlling party. The controlling party has an incentive to follow this recommendation if uninformed and to overrule the project and implement his or her preferred project if informed. It follows that under P-Formal authority, the utilities of a risk-neutral principal and agent are

$$EV_P = E\hat{P}_1 + (1-E)e\hat{P}_2 + P_0 - g_P(E), \tag{1.1}$$

$$EV_A = E\hat{A}_1 + (1-E)e\hat{A}_2 + A_0 - g_A(e), \tag{1.2}$$

where

$$\hat{P}_i = P_i - P_0, \textit{ for } i \in \{1,2\}, \tag{1.3}$$

$$\hat{A}_i = A_i - A_0, \textit{ for } i \in \{1,2\}. \tag{1.4}$$

[7] Aghion and Tirole (1997) refer to this case as the agent having real authority.

Under A-Formal authority, the utility of the principal and agent are

$$EV_P^d = (1-e)E\hat{P}_1 + e\hat{P}_2 + P_0 - g_P(E), \tag{1.5}$$

$$EV_A^d = (1-e)E\hat{A}_1 + e\hat{A}_2 + A_0 - g_A(e), \tag{1.6}$$

where the $d$ in the A-Formal utility functions stands for the mnemonic *delegation*.

From Equations 1.1 and 1.2, the reaction functions under P-Formal authority are the solutions to:

$$\hat{P}_1 - e\hat{P}_2 = g'_P(E), \tag{1.7}$$

$$(1-E)\hat{A}_2 = g'_A(e). \tag{1.8}$$

Equation 1.7 describes the principal's reaction function which we denote by $r_P(e)$. Equation 1.8 describes the agent's reaction function denoted by $r_A(E)$. Note that both $r_P(e)$ and $r_A(E)$ are downward sloping in $(E,e)$-space, implying that the principal's and agent's effort level are strategic substitutes. Thus, an increase in the agent's effort induces the principal to reduce her effort and vice versa. In order to ensure a unique and stable intersection of the reaction function in $(E,e)$-space, we assume that the absolute value of the agent's reaction function (given by $\frac{g''_A}{\hat{A}_2}$) is larger than the absolute value of the principal's reaction function (given by $\frac{\hat{P}_2}{g''_P}$).

Looking at the reaction functions under P-Formal authority with $\hat{A}_2$ and $\hat{P}_1$ constant, the principal's effort is decreasing in $\hat{P}_2$. The more value that the principal receives at the agents preferred project, the less incentive he has to get informed himself to overrule the agent. This leads to an increase in effort by the agent since it is more likely that the project he suggests will be implemented. Notice also that neither the principals' nor the agents' best response function depends on $\hat{A}_1$, the agents valuation under the principals best project.

The same logic applies under A-Formal authority, where the reaction curves of the principal and agent are the solutions to:

$$(1-e)\hat{P}_1 = g'_P(E), \tag{1.9}$$

$$\hat{A}_2 - E\hat{A}_1 = g'_A(e), \tag{1.10}$$

and denoted by $r_P^d(e^d)$ and $r_A^d(E^d)$. As in the case of P-Formal authority, the re-

action functions are downward sloping in $(E^d, e^d)$ space. Under similar stability and uniqueness criteria, there exists an interior intersection of reaction functions, $(e^{d^{NE}}, E^{d^{NE}})$, which constitutes the Nash equilibrium. Given the symmetry in the best response functions, it is unsurprising that under A-Formal authority, the agent's effort is decreasing in $\hat{A}_1$, the principal's effort is increasing in $\hat{A}_1$, and $\hat{P}_2$ does not affect the equilibrium effort choices.

A careful examination of the reaction functions under P-Formal authority and A-Formal authority reveals that the principal decreases her effort moving from P-Formal authority to A-Formal authority while the agent increases his effort. Delegation by the principal thus has two effects in our model: 1) a cost saving effect since delegation reduces the equilibrium effort of the principal, and 2) a project selection effect which decreases the probability that the principal's preferred project is undertaken. As these effects are, in general, of opposite sign, the overall incentive for delegation depends on the specifics of the cost function and the degree of interest alignment. In our experiment, we chose cost functions and parameters such that the magnitude of $\hat{P}_2$ determines whether delegation or retention is optimal for the principal. Full details of the experimental design and its parameterizations are discussed in more detail in the next section.

## *1.3 The Experiment*

### *1.3.1 The Authority Game*

At the center of our experimental design is a computerized authority-delegation game with the following features. In each of ten periods, a principal is matched with an agent and shown a set of 36 cards on her computer screen representing potential projects.[8] One of these cards has a small positive payoff for both players and is placed face up representing the outside option. The remaining thirty five cards are shuffled face down so that the location of each project is unknown. One of these cards is red and represents the principal's preferred project. Following the theory section, we refer to this card as project 1. A second card is blue and represents the agent's preferred project. We refer to this card as project 2. The remaining thirty-

[8] Subjects are randomly assigned the role of a principal or of an agent and remain in this role throughout the experiment.

three cards are white and result in zero payoff for both parties. These cards ensure that individuals prefer to implement the outside option relative to implementing a project at random. The task of each principal-agent pair is to select a card which will be used for payment.

Play of the game is done in six stages which are illustrated in Figure 1.1 and discussed here. Initially principals' are given the decision right which corresponds to being able to select a card at the end of the game. In the first stage of the game, each principal is asked whether he wishes to keep this right or to transfer the right to the agent. Giving the right to the agent is binding and irreversible.

In the second stage, subjects choose their effort levels simultaneously and in private.[9] Both subjects select their effort in increments of 5 from $\{0, 5, \ldots, 95, 100\}$. This effort corresponds to the probability that the subject learns the location of all projects. Effort has an associated cost generated via a quadratic cost function which is constant across treatments and player types:

$$g_P(E) = 25\left(\frac{E}{100}\right)^2, \quad g_A(e) = 25\left(\frac{e}{100}\right)^2. \tag{1.11}$$

Subjects are presented information on the cost of effort in a table where each possible effort and its associated cost is displayed. Agents' effort levels are recorded via the strategy method where an effort level is elicited both for the case where principals keep decision rights and the case where these rights are delegated.[10] Thus, agents choose their effort levels for both authority structures before they know whether the principal has delegated authority to them.

In the third stage, we elicit beliefs of both subjects. Principals and agents are asked their beliefs about the effort of the other party both in the case where decision rights are kept and where they are delegated. For principals this is done in two steps. Beliefs are first elicited for the chosen authority structure followed by beliefs

[9] In the experiment we refer to effort as "search intensity".

[10] We test whether the strategy method influences our results by comparing results to treatments that use a standard elicitation method. We find no difference across treatments. P-Values of a Kolmogorov-Smirnov test whether the distribution of agent effort is identical in treatments with and without strategy method are 0.70 for effort with decision rights and 0.72 for effort without decision rights. Delegation frequencies differ by 1.6 percent. This difference is also not significant (p=0.62 in a Fisher's exact test)

for the counterfactual. For agents, beliefs for both authority structures are elicited simultaneously. To prevent hedging, no incentives are used in the elicitation of beliefs.[11] In the fourth stage, agents are informed about whether principals kept or transferred decision rights. Then, given a subject's effort in the chosen authority structure, a random process determines whether that subject learns the payoffs of all projects or whether he stays uninformed. The effort of the other subject is not revealed nor is information indicating the success or failure of the other subject's effort. All information gained at this stage is private.

In the fifth stage, the subordinate is given the ability to recommend a project to the controlling party. This is accomplished by visibly marking a single project on the computer screen, which can include the outside option. The recommendation is shown to the controlling party, but the payoffs associated with the recommended project are kept hidden in the case where the controlling party remains uninformed.

In the final stage, after seeing the recommendation of the subordinate and the information from his own effort, the controlling party selects a project. Payment for the round is based on the selected project and the costs of effort of each subject.

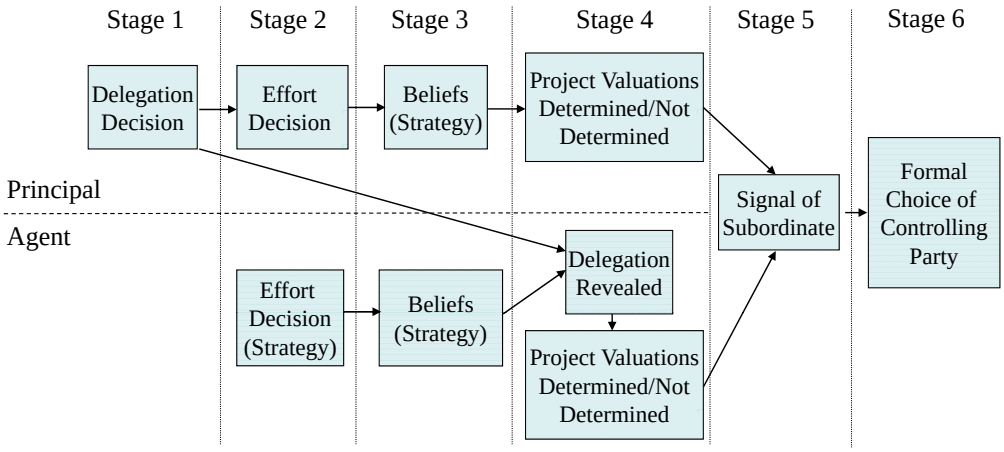



*Figure 1.1:* Experimental procedures in the authority game

[11] See Blanco, Engelmann, Koch, and Normann (forthcoming) for a discussion of hedging

### *1.3.2 Experimental Design and Hypotheses*

The experimental design involves four treatments implemented in a between-subject design. Treatments vary in the amount that principals and agents are paid for the selection of the project preferred by the other party ($\hat{P}_2$ and $\hat{A}_1$). By changing the payoff given to the other party, the level of incentive conflict in the environment is changed, which, as shown in section 1.2.1, leads to differences in predicted delegation and effort levels.

Table 1.1 summarizes the value of projects across the four treatments. In each treatment, each party earns 40 points for the selection of their preferred project and a smaller amount for the other party's preferred project. Treatments are divided into two groups — symmetric and asymmetric — where symmetry refers to the relative values of $P_2$ and $A_1$. In the symmetric treatments (LOW and HIGH) the payoffs from the other party's preferred project are the same for the principal and agent. In the low alignment treatment (LOW), the payoffs from the other party's preferred project are small (20) leading to a high degree of incentive conflict. In the high alignment treatment (HIGH), the payoffs from the other party's preferred project are large (35) leading to less incentive conflict. In the asymmetric treatments (PLOW and PHIGH), the payoffs from the other party's preferred project are large for one of the two parties (35) and small for the other (20). As a naming convention, we use PHIGH to denote the case where the principal's value is high under the agent's preferred project. The PLOW treatment is the case where the principal's value is low under the agent's preferred project.

*Table 1.1:* Overview of Project Payoffs

| | **Project 1** | | **Project 2** | | **Outside** | **Other** |
|---|---|---|---|---|---|---|
| | Principal | Agent | Principal | Agent | **Option** | **Projects** |
| **PLOW** | 40 | 35 | 20 | 40 | 10 | 0 |
| **LOW** | 40 | 20 | 20 | 40 | 10 | 0 |
| **HIGH** | 40 | 35 | 35 | 40 | 10 | 0 |
| **PHIGH** | 40 | 20 | 35 | 40 | 10 | 0 |

Table 1.2 shows the predicted Nash equilibrium effort levels and expected profits for each treatment under the case where authority is kept (P-Formal authority) and transferred (A-Formal authority). As in the model developed in Section 1.2, $E$

represents the effort level of the principal while $e$ represents the effort level of the agent. As can be seen in this table, the LOW treatment has a high degree of incentive conflict and authority should be kept by the principal, because the principals expected profit under P-Formal, $EV_P$, is 20.1 while the expected payoff under A-Formal, $EV_P^d$, is only 17.3. In the HIGH treatment, incentive conflict is reduced and the principal should delegate authority ($EV_P = 23.3$ vs. $EV_P^d = 24.0$).

*Table 1.2:* Predicted effort levels and expected profits

| | **P-Formal** | | | | **A-Formal** | | | | **Deleg-** |
|---|---|---|---|---|---|---|---|---|---|
| | $E^{NE}$ | $e^{NE}$ | $EV_P$ | $EV_A$ | $E^{d^{NE}}$ | $e^{d^{NE}}$ | $EV_P^d$ | $EV_A^d$ | **ation?** |
| **PLOW** | 55 | 25 | 20.1 | 25.6 | 35 | 45 | 17.2 | 23.3 | No |
| **LOW** | 55 | 25 | 20.1 | 17.3 | 25 | 55 | 17.3 | 20.1 | No |
| **HIGH** | 45 | 35 | 23.3 | 24.0 | 35 | 45 | 24.0 | 23.3 | Yes |
| **PHIGH** | 45 | 35 | 23.3 | 17.2 | 25 | 55 | 25.6 | 20.1 | Yes |

$E^{NE}$ and $E^{d^{NE}}$ denote Nash equilibrium predictions for the principal under P- and A-formal authority.
$e^{NE}$ and $e^{d^{NE}}$ denote Nash equilibrium predictions for the agent under P- and A-formal authority.
$EV_P$, and $EV_P^d$ denote expected equilibrium profits for the principal under P- and A-formal authority.
$EV_A$ and $EV_A^d$ denote expected equilibrium profits for the agent under P- and A-formal authority.

In the asymmetric treatments the rewards to delegation are either exacerbated or further diminished relative to the symmetric treatments. Of the four treatments, principal's are predicted to have the highest expected value from delegation in the PHIGH treatment ($EV_P^d = 25.6$) and the lowest expected value from delegation in the PLOW treatment ($EV_P^d = 17.2$).

In addition to the delegation predictions, the different interest alignments also lead to different predictions with regard to equilibrium effort levels. All point estimate predictions are given in Table 1.2. Note that the delegation decisions predicted by the Nash equilibrium are always in the set of welfare maximizing delegation choices. In PLOW aggregate expected earning $EV_p + EV_A$ are highest if the principal keeps control, while in PHIGH overall welfare is highest if the principal delegates authority. In the symmetric treatments, LOW and HIGH, the delegation decision has no effect on the overall welfare if subjects choose Nash equilibrium effort levels.

In the experiment described above the principals are endowed with the right

to choose the project. Thus, if principals value authority per se, loss aversion can play a role here because more loss averse principals may be more reluctant to give up authority than less loss averse principals. In order to better understand the potential individual heterogeneity in delegation decisions, we therefore measured subjects loss aversion with a lottery choice task. Each subject was presented with the opportunity to participate in six different lotteries, each having the following form:

> Win CHF 6 with probability $\frac{1}{2}$, lose CHF X with probability $\frac{1}{2}$. If subjects reject the lottery they receive CHF 0.

The six lotteries varied in the amount $X$, that could be lost, where $X$ took on the values $X \in \{2, 3, 4, 5, 6, 7\}$. One of the six gambles was randomly selected and paid. These lotteries enable us to construct individual measures of loss aversion. The amount $X$ at which a subjects starts rejecting the lottery is an indicator of a subjects' loss aversion. For example, a subject that rejects all lotteries with a potential loss of $X > 3$ is classified as more loss averse than a subject that only rejects all lotteries with a potential loss of $X > 5$.[12]

In principle, one might think that the rejection of these lotteries is also compatible with risk aversion arising from diminishing marginal utility of lifetime income. Matthew Rabin's calibration theorem (Rabin (2000)) rules out this interpretation, however. Rabin shows that a theory of risk averse behavior based on the assumption of diminishing marginal utility of *lifetime* income implies that people essentially must be risk neutral for low-stake gambles like our lotteries. Intuitively, this follows from the fact that risk-averse behavior for low-stake gambles implies ridiculously high levels of risk aversion for slightly higher, but still moderate, stake levels. Yet, such unreasonably high levels of risk aversion can be safely ruled out. For example, we show in the appendix that if one assumes that the rejection of the lottery with $X = 4$ is driven by diminishing marginal utility of lifetime income, then the subject will also reject a lottery where one can lose \$30 with probability $\frac{1}{2}$ and win *any* price with probability $\frac{1}{2}$. Thus, there is no finite prize that induces this subject to accept a 50-percent chance of losing \$30. Similar results are implied by rejection of lotteries with other potential losses $X$.

[12] 74 out of 75 subjects who participated in the lottery task and played the authority-delegation game as a principal have a unique switching point.

### *1.3.3 Procedures*

30 subjects participate in each experimental session which consists of three parts.[13] In part one, subjects play 7 periods of a single player version of the authority game. This single player game is identical to the authority game except there is no second party. Subjects choose an effort and receive information probabilistically based on their effort. Each individual must then select a project based solely on their own information. The selected project does not affect the payoff of a second party nor does a second party recommend a project. This single player variant gives subjects a chance to get familiar with the effort cost schedule and the computer program.

In part two, subjects play 10 periods of the main authority game in one of the four treatments. The 30 subjects are divided into 3 matching groups of 10 subjects consisting of 5 principals and 5 agents. Subjects are informed that in a new period they would be matched with another randomly chosen partner.

In part three, subjects are asked to take a short questionnaire in which gender and other demographics information is recorded. Instructions for the experiment include a control quiz and a verbal summary of the authority game.

Our subject pool consisted primarily of students at Zurich University and the Federal Institute of Technology in Zurich.[14] The first series of experiments took place in May and June 2007 with a second series of experiments conducted in May and October 2008 and a third series in May 2009. In total, 380 subjects participated in the experiment, divided into 13 sessions. Experiments were computerized using the software z-tree (Fischbacher (2007)). Payment was given for each period of the main authority game and for the last five periods of the single player game. On average, an experimental session lasted one hour with an average payment of 33.5 CHF ($33.00 at the time of the experiment).

[13] One session consisted of only 20 subjects.

[14] Subjects were drawn from a database of volunteers using ORSEE (Greiner (2004)).

## *1.4 Experimental Results*

### *1.4.1 The Main Facts*

Our experimental design generates predictions with regard to delegation, effort and project choices. With regard to project choices and project recommendations the theory does very well:

**Result 1** *If the controlling party is informed about the project valuations it almost always chooses its preferred project, implying that it overrules the subordinates recommendations. Informed subordinates almost always recommend their preferred project and uninformed principals almost always implement this recommendation.*

Result 1 is supported by the following numbers. Controlling parties in the role of the principal (agent) who were informed implemented their preferred project in 100 percent (98.3 percent) of the cases. Principals (agents) in the role of the informed subordinate party recommended their preferred project in 93.4 percent (94.3 percent) of the cases. Finally, principals (agents) in the role of the uninformed controlling party followed the subordinate party's recommendation in 94.2 percent (96.5 percent) of the cases. The high credibility of the subordinate's advice stems from the fact that they rarely misled the controlling party. If the subordinate parties were not informed they typically recommended the outside option (principals: 95.2 percent ; agents: 97.3 percent)

Result 1 indicates that the controlling parties used the decision right in their favor. This generates a disincentive for subordinates' effort provision but it also makes it reasonable for the principals to delegate authority if their payoff loss at the agents' preferred project is low. Therefore, we next turn to the principals' delegation choices. Recall that in case of Nash equilibrium effort choices by the principal and agent, the principal has an incentive to delegate decision rights in the HIGH and PHIGH treatments and to keep authority in the LOW and PLOW treatments. Empirically, we find in our experiment:

**Result 2** *(a) When the principals' interests are misaligned with the agent (LOW and PLOW) such that the principals are predicted to keep authority, delegation decisions are close to the equilibrium predictions. (b) When the principals' interests are strongly aligned*

*with the agent (HIGH and PHIGH treatments) such that principals should delegate, we observe strong under delegation of authority relative to the equilibrium predictions.*

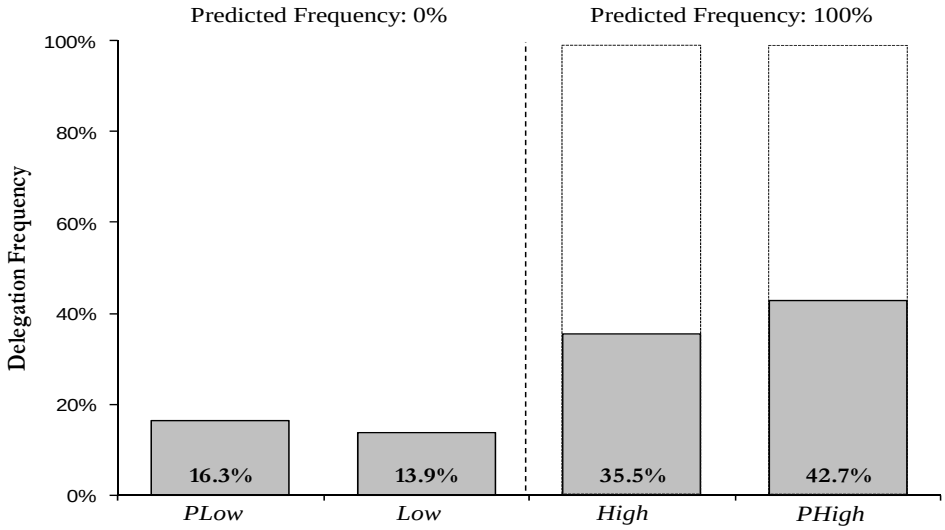



*Figure 1.2:* Delegation frequencies by alignment

Figure 1.2 shows the frequency of delegation for each treatment graphically. As can be seen on the left hand side of the figure, delegation rates in the PLOW and LOW treatments are 16.3 percent and 13.9 percent. While these levels are above the predicted level of zero, deviations from prediction appear to be due to infrequent experimentation rather than heterogeneity in delegation strategies. There is little persistence in the strategy of delegation, with 67.4 percent of individuals who delegated authority in one period switching to keeping authority in the next. The frequency of delegation for most individuals is also low, with 39.4 percent of individuals choosing to never delegate and 89.4 percent of individuals delegating in three periods or less.

Delegation rates in the HIGH and PHIGH treatment are 35.5 percent and 42.7 percent, far below the predicted rate of 100 percent. These low delegation rates are also rather stable over time. In the HIGH treatment the overall delegation rate is 33.5 percent in the first five periods and 37.5 percent in periods 6-10. From period 2 onwards the delegation rate is roughly constant at 37.2 percent in this treatment.

In the PHIGH treatment the overall delegation rate is 36.7 percent in the first five periods and stabilizes at roughly 48.7 percent from period 6 onwards.

In contrast to the LOW and PLOW treatments, the under delegation of authority in the HIGH and PHIGH treatments appears to be due to heterogeneity in delegation strategies across individuals. Less than 20 percent of individuals delegate seven or more times in the experiment, and individuals who delegate in one period are more likely to delegate in the next period suggesting some persistence in the delegation strategy. However, even in the PHIGH treatment in which delegation incentives are highest according to the Nash prediction, 30 percent of individuals have a delegation frequency of zero suggesting that under delegation is rather pervasive.

One possible reason for the observed under delegation might be that actual effort provision in P-Formal and A-Formal authority makes it more profitable to keep authority. Table 1.3, which shows the realized profits of principal's who kept and delegated authority, shows that this is not the case. In the HIGH and PHIGH treatments, realized profits for the principal are lower than predicted under P-Formal authority and higher than predicted under A-Formal authority. Principals who delegate have on average 30.3 percent greater earnings in the HIGH treatment and 45.5 percent greater earnings in the PHIGH treatment.

*Table 1.3:* Realized profits and predicted equilibrium profits for principals

| | **P-Formal** | | Number | **A-Formal** | | Number |
|---|---|---|---|---|---|---|
| | Actual | Predicted | of Obs. | Actual | Predicted | of Obs. |
| PLOW | 18.4 ** | *20.1* | 251 | 17.6 | *17.2* | 49 |
| LOW | 19.0 | *20.1* | 310 | 15.0 *** | *17.3* | 50 |
| HIGH | 19.1 *** | *23.3* | 316 | 24.9 | *24.0* | 174 |
| PHIGH | 18.4 *** | *23.3* | 172 | 26.6 | *25.6* | 128 |

Significance levels calculated by regressing earnings on a constant and testing whether the constant is equal to the prediction. Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

The second main hypothesis of the experiment is about effort provision. In theory, an incentive conflict leads the controlling party to put in more effort than would be optimal in the case of contractible effort and causes the subordinate to put in less. Relative to this Nash equilibrium benchmark, we observe:

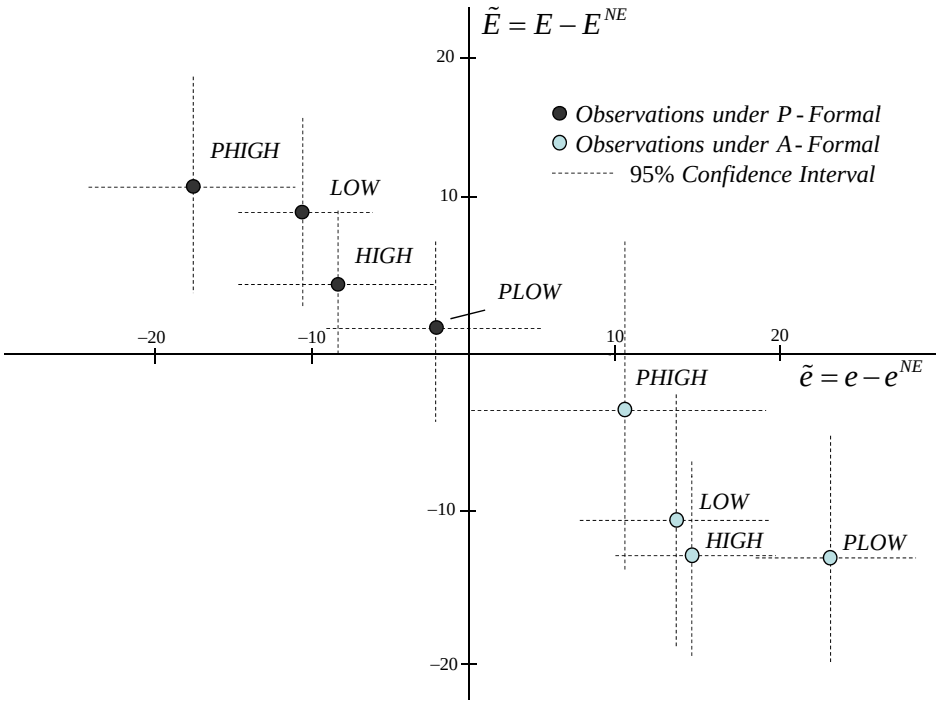
**Result 3** *Controlling parties provide an excess of effort relative to the Nash equilibrium. Subordinates strongly under provide effort relative to the Nash equilibrium.*

Figure 1.3 plots the average deviation of effort levels from the predicted equilibrium values by the principal and agent with both means and 95 percent confidence intervals calculated from individual average efforts. It can be seen that, when authority is kept, the principal over provides and the agent under provides relative to the prediction. This phenomenon is reversed, again in all treatments, when authority is delegated, and these deviations are significant for the majority of treatments.[15] In the low treatment, for example, the principal over provides effort by roughly 10 units relative to the prediction under P-Formal authority while the agent under provides effort by about 10 units. This deviation pattern is reversed under A-Formal authority when the agent is the controlling party.

Recall that in the Nash equilibrium the controlling party provides too much, and the subordinate party too little effort relative to the welfare maximizing effort levels. The fact that the controlling party over provides and subordinate party under provides effort relative to the equilibrium means that the actual effort allocation across parties is even more inefficient than in the predicted equilibrium. This inefficiency is reflected in the low actual payoff levels of the principals and the agents relative to the predicted payoff levels. Table 1.3 shows that the principals earn less than predicted in 5 out of 8 cases. In particular, under P-Formal authority, which occurs most frequently in all treatments, the principals always earn less than predicted. For the agents the income loss relative to the prediction is even more extreme (see Table 1.4): In all 8 cases they earn on average less than predicted.

As predicted by the model, the total welfare of the principal and agent are higher under delegation in both the HIGH and PHIGH treatments. Thus, the inefficiency of effort allocation is further exacerbated by the inefficiency in delegation. This effect is particularly acute in the PHIGH treatment in which delegation of authority would have made both parties better off. Comparing the average realized profits of principals and agents to the equilibrium profits *under the equilibrium authority structure* shows, that on average, earnings are between 8.5 percent and 14.4

[15] We report results from a non-parametric Wilcoxon Signed-Rank test in Table 1.11 of Appendix A.




95% Confidence Intervals and mean effort calculated at the individual level.

*Figure 1.3:* Deviations from equilibrium effort predictions

percent lower than predicted for the principal and between 5.7 percent and 16.2 percent lower for the agent. [16] We can therefore conclude:

**Result 4** *The deviation in effort provision and delegation leads to welfare losses by both parties in all treatments. Welfare losses are most acute in the PHIGH treatment where delegation would make both parties better off.*

### *1.4.2 Exploring the principals' reluctance to delegate*

A natural initial hypothesis for the observed under delegation of authority in the HIGH and PHIGH treatments is that individuals believe that they are better off

[16] see Table 1.12 of appendix A.

*Table 1.4:* Realized profits and predicted equilibrium profits for agents

| | **P-Formal** | | Number | **A-Formal** | | Number |
|---|---|---|---|---|---|---|
| | Actual | Predicted | of Obs. | Actual | Predicted | of Obs. |
| PLOW | 23.0 *** | *25.6* | 251 | 18.8 ** | *23.3* | 49 |
| LOW | 16.1 *** | *17.3* | 310 | 17.9 | *20.1* | 50 |
| HIGH | 21.1 *** | *24.0* | 316 | 20.1 *** | *23.3* | 174 |
| PHIGH | 15.9 ** | *17.2* | 172 | 18.1 * | *20.1* | 128 |

Significance levels calculated by regressing earnings on a constant and testing whether the constant is equal to the prediction. Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

retaining authority. To see whether this hypothesis has merit, we consider the following counterfactual: Suppose that a principal who did not delegate would elect to delegate instead. Given his beliefs about the agents actions under both P-Formal and A-Formal authority, what would be his gain or loss in expected earnings?

As the effort of the principal was elicited only in the case of her chosen authority structure a comparison of the principal's expected earnings for the case of delegation and non-delegation requires assumptions about her effort in the counterfactual authority structure. As we have beliefs data from both the delegation case and non-delegation case, a natural approach is to use the principal's best reply effort as a proxy for effort. If, for example, the principal kept authority we can compute the principal's best reply effort for the case in which the principal had delegated authority. Using this effort proxy and the principal's belief about the agent's effort enables us to compute the principal's expected profit for the counterfactual case of delegation.[17]

As a comparison value, we next compute the expected profits of the principal for the case of retained authority, taking the principal's actual effort and his beliefs

[17] Under the assumption that the principal best replies to his beliefs the expected earnings for the counterfactual case of delegation is given by:

$$EV_P^d(E^d = r_P^d(\hat{e}^d), \hat{e}^d) = \hat{e}^d \hat{P}_2 + (1 - \hat{e}^d) r_P^d(\hat{e}^d) \hat{P}_1 + P_0 - g_P(r_P^d(\hat{e}^d)), \tag{1.12}$$

where $\hat{e}^d$ is the principal's belief about the agent's effort under delegation, $P_0$ is the principal's payout under the outside option, $\hat{P}_2$ is the principal's payment under the agents preferred project net of $P_0$, $\hat{P}_1$ is the principal's payment under the principal's preferred project net of $P_0$, and $r_P^d(\hat{e}^d)$ is the best response function constructed in Equation 1.9.

about the agent's effort into account.[18] Subtracting the expected profit from retained authority from the expected profit from delegation yields our first measure for the expected gains from delegation.

Figure 1.4 shows the cumulative density function of the gains from delegating under the assumption that the principal would have played a best reply in case he had delegated. As can be seen in this graph by looking at the mass to the right of the zero line, 68 percent of observations in the HIGH treatment and 92 percent of observations from the PHIGH treatment are from individuals who would have been better off if they had delegated. The retention of authority in the PHIGH treatment is especially noteworthy since both the principal and the agent would be made better off through delegation. Thus, in this treatment, the under delegation is suboptimal not only from the principals' perspective, but also from the perspective of the organization as a whole.

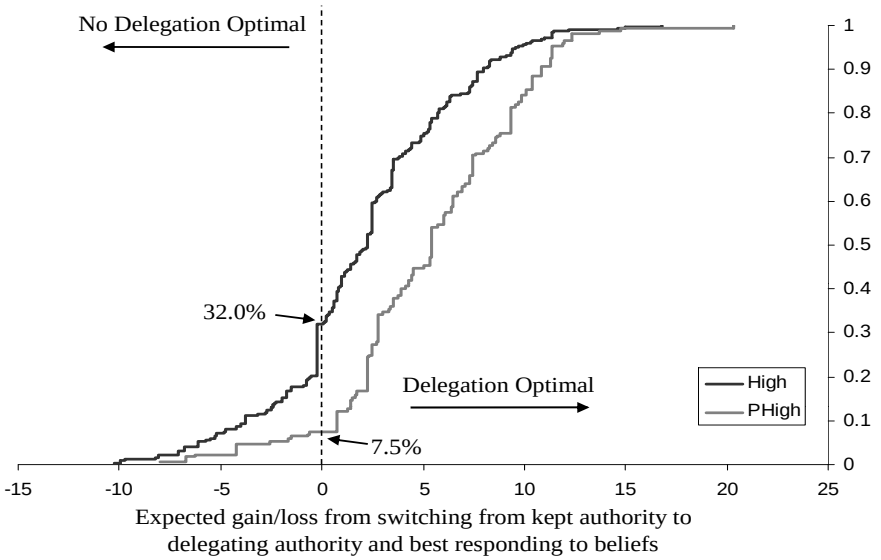



*Figure 1.4:* Cumulative density function of expected gain from delegation if principal best replies to beliefs

[18] This comparison value is given by

$$EV_P(E, \hat{e}) = E\hat{P}_1 + (1 - E)\hat{e}\hat{P}_2 + P_0 - g_P(E). \tag{1.13}$$

One might worry that using the best response to beliefs as a proxy for effort might overstate the expected return to delegation. Perhaps, some individuals may not perfectly best respond to their beliefs.

As a conservative secondary measure for the expected gains from delegation, we next consider the case where the principal provides zero effort after delegation. This criterion is selected for three reasons. First, an individual who puts in zero effort has no potential losses and minimal exposure to risk. Relative to the actual strategies typically employed by principals, the zero effort criterion should thus be an attractive strategy for principals under A-Formal authority even with extreme risk and loss aversion. Second, besides very high effort choices which are observed very infrequently, zero effort minimizes the expected value for delegation giving us the lowest reasonable expected value for delegation. Finally, zero effort is in fact the modal strategy taken after delegation suggesting it is a relevant benchmark for analysis.

In Figure 1.5 we depict the cumulative density function for the expected gains from delegation under the assumption that the principal would have chosen zero effort if he had delegated. We find, that 46.8 percent of observations in the HIGH treatment and 75 percent of observations in the PHIGH treatment are from individuals who would have been better off in case of delegation. This result is remarkable because even if we assume that principals choose highly suboptimal effort levels after delegation, it would have often been better for them (given their beliefs) to delegate authority.

The results above suggest that the principals had little or no pecuniary reason to retain authority in the HIGH and PHIGH treatment. In fact, a large share of the principal's had strong pecuniary incentives to delegate. Why then do we observe this strong reluctance to delegate?

One potential explanation is that people receive direct value from holding decision rights, independent of any monetary consequences or associated risk. Assigning value to decision rights changes the trade-off between delegation and retention of authority. If subjects value decision rights per se, they may perceive the delegation of control rights as a loss. Loss aversion could then amplify the likelihood to keep decision rights. This hypothesis would be supported by evidence showing that individuals who are more loss averse are more likely to keep control.

To study this hypothesis, we turn to regression analysis. We first run the fol-

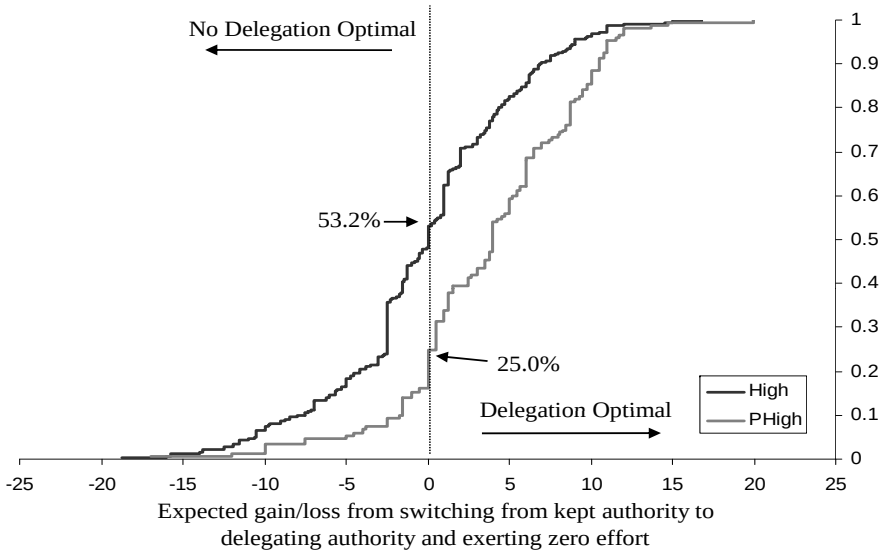



*Figure 1.5:* Cumulative density function of expected gain from delegation and if principal chooses zero effort after delegation

lowing regression

$$Del_{i,t} = \alpha_0 + \Sigma\alpha_t + \beta_{PLOW} I_{PLOW} + \beta_{HIGH} I_{HIGH} + \beta_{PHIGH} I_{PHIGH} + \epsilon_{i,t}, \quad (1.14)$$

where $I_{PLOW}$, $I_{HIGH}$, and $I_{PHIGH}$ are treatment indicator variables and the LOW treatment is the omitted category. As the delegation decision is discrete, we use a probit specification with data clustered at the individual level. All results reported are robust to a linear specification of the regression model, a panel probit model, or a poisson regression which uses the absolute delegation frequency of principals as the dependent variable. We report the probit results from regression 1.14, and extensions of it, as these have the best controls for possible learning over time.[19]

Column (1) of Table 1.5 shows the marginal effects of the probit regression. The delegation prediction from section 1.3.2 predicts that $I_{HIGH} = I_{PHIGH} = 1$ and

[19] As noted in the previous section, there is a small time trend in the HIGH and PHIGH treatments. The specification shown uses period fixed effects and period fixed effects interacted with the HIGH and PHIGH treatments as controls. Omitting these controls or replacing them with a linear time trend does not affect the stated results.

$I_{PLOW} = 0$. While the HIGH and PHIGH treatments are significantly different from the LOW treatment baseline, their magnitudes are significantly smaller than the predictions. Column (2) extends this regression to include beliefs and gender. As can be seen in the coefficients on the beliefs variables, a principal who believes the agent will put in more effort under A-Formal authority and less effort under P-Formal authority is more likely to delegate. Gender effects in delegation appear to be small and not significant.

Columns (3) and (4) present our main results with regard to loss aversion. As seen in Column (3), which includes observations from all four treatments, loss aversion strongly correlates with held authority. At the margin, subjects across all treatments are 6.9 percent more likely to keep authority for each additional gamble rejected in the lottery treatment. This effect is diluted, however, as individuals in the LOW and PLOW treatment are not expected to delegate. When the observations are restricted to only the HIGH and PHIGH treatments, as in Column (4), the effect of loss aversion is magnified, with a 12.6 percent decrease in probability of delegating for each gamble declined. As the variance of loss aversion is high (the standard deviation is 1.41 lotteries), loss aversion appears to constitute a major force in the under delegation phenomenon. In fact, combining observations in the HIGH and PHIGH treatment, the difference in delegation frequency between the group with high loss aversion (above the median) and low loss aversion (below the median) is 20 percent.

If loss aversion is a major driving force in the delegation decision, we should also see its fingerprint in other parts of our data. Kahneman and Tversky (1991) have shown theoretically that there is a positive relationship between an individual's loss aversion in risky choices and the individual's proneness to the endowment effect. The endowment effect means that individuals value a good more highly because of the mere fact that they possess the good. Thus, even if they are randomly endowed with the good, they value it more. The strong negative impact of loss aversion on the delegation decision therefore suggests that there may also be an endowment effect with regard to authority, i.e. the principals (who have been randomly endowed with authority) may display a higher preference for authority than the agents. In a survey conducted at the end of the sessions with the HIGH treatment run in 2008, we asked individuals whether they (a) preferred to have authority, (b) were indifferent to the authority allocation, or (c) preferred not

*Table 1.5:* Delegation decisions by principals

| | (1) | (2) | (3[a]) | (4[b]) |
|---|---|---|---|---|
| PLOW | 0.034 | 0.061 | 0.100 | |
| | (0.068) | (0.073) | (0.079) | |
| HIGH | 0.246*** | 0.216** | 0.503*** | |
| | (0.062) | (0.090) | (0.133) | |
| PHIGH | 0.328*** | 0.252** | 0.535*** | –0.003 |
| | (0.086) | (0.117) | (0.148) | (0.145) |
| Female (d) | | 0.061 | 0.049 | 0.056 |
| | | (0.048) | (0.068) | (0.152) |
| Beliefs P-Formal | | –0.002** | –0.002 | –0.005 |
| | | (0.001) | (0.001) | (0.003) |
| Beliefs A-Formal | | 0.003*** | 0.006*** | 0.012*** |
| | | (0.001) | (0.002) | (0.004) |
| Loss Aversion | | | –0.069** | –0.126** |
| | | | (0.027) | (0.055) |
| Period Dummies? | Yes | Yes | Yes | Yes |
| Pseudo. $R^2$ | .073 | .116 | .181 | .178 |
| Observations | 1450 | 1450 | 750 | 300 |

Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Probit regression with marginal effects shown.
[a] Loss aversion measures are available only for sessions conducted in 2008.
[b] Column (4) includes data only from the HIGH and PHIGH treatments for which we have a loss aversion measure. HIGH is the omitted category.

having authority. Table 1.6 shows the proportion of principals and agents who prefer having authority. As can be seen in the first column, 73 percent of Principals prefer to be the controlling party while only 20 percent prefer to be in the role of the subordinate. By contrast, agents are much more likely to prefer the subordinate role and are much less likely to prefer being the controlling party. The principals' strong preference for authority is quite remarkable because in case of delegation the principals earn on average 24.87 while if they keep authority they only earn 19.07 on average. Therefore, this strong preference for authority cannot be explained by the pecuniary experiences of the principals during the experiment. If anything, the pecuniary experiences in the experiment should have taught them to prefer the subordinate role. Thus taken together our data strongly supports an endowment effect in authority.

*Table 1.6:* Principals' and agents' preferences for authority in the exit survey

| | Type | |
|---|---|---|
| **Preferred Role** | Principal | Agent |
| Controlling Party | 0.73 | 0.20 |
| Indifferent | 0.07 | 0.33 |
| Subordinate | 0.20 | 0.47 |
| Observations | 15 | 15 |

Fisher's exact test of the null hypothesis
that Principals and Agents have the same preferences
yields a p-value of .018

We summarize the findings in this subsection by

**Result 5** *On the basis of the principals' own beliefs about the agent's effort choices the principals' would often have been better off by delegating authority in the HIGH and PHIGH treatment. In addition, loss aversion of the principal appears to be an important determinant of the reluctance to delegate suggesting an endowment effect in decision rights.*

### *1.4.3 Exploring the controlling parties' over provision of effort*

We saw in Figure 1.3 that the provision of effort by the controlling party exceeds the Nash equilibrium prediction across all treatments while the effort of the subordinate is below the Nash prediction. These deviations are persistent, with no apparent convergence to the Nash equilibrium over time.

Persistent deviations from the Nash equilibrium might be due to one of two sources. First, for a given belief about the other parties effort, an individual may respond to those beliefs differently than the best reply. For example, if the controlling party systematically over provides effort relative to their best reply, its effort is likely to be higher than the Nash equilibrium effort. Likewise, if the subordinate party under provides effort relative to its best reply, then the effort of the subordinate is likely to be below that of the Nash equilibrium.

Second, beliefs about the other parties effort provision may deviate from those predicted in the Nash equilibrium. Because of strategic substitutability, a controlling party whose beliefs about subordinate effort are below those predicted by the Nash equilibrium will increase its effort relative to the Nash equilibrium. Likewise

a subordinate party whose beliefs are above the Nash equilibrium will decrease effort in substitution. In this subsection we examine both the best reply channel and the belief channel as potential sources of the controlling parties' over provision of effort.

We first look at systematic deviations from the best response function by constructing the theoretical best response for the controlling party in both P-Formal and A-Formal authority under the assumption of risk neutrality:

$$r_P(\hat{e}) = \frac{100\hat{P}_1 - \hat{e}\hat{P}_2}{50}, \qquad r_A^d(\hat{E}^d) = \frac{100\hat{A}_2 - \hat{E}^d\hat{A}_1}{50}. \tag{1.15}$$

By comparing these best responses with the actual response of the controlling party to their beliefs, we can examine systematic deviations from the best response function.

Figure 1.6 shows this comparison for the HIGH treatment. The dashed 45° line represents those cases when the actual effort response to beliefs coincides with the best response to these beliefs. Points above the 45° line represents observations in which the controlling party over provides relative to the best response while points below the 45° line represents an under provision of effort.

The solid line in Figure 1.6 shows the empirical relationship between the actual response to beliefs about the subordinates' effort and the best response. The positive slope of this line indicates that the best response has some (qualitative) predictive power. However, the overwhelming feature in the data is the systematic over provision of effort by the controlling party relative to the best response. Counting all observations strictly above the 45° line, 67 percent of observations for principals and 76 percent of observations for agents provide more effort than is predicted by a best response to beliefs. The magnitude of this over provision is typically large, with over 50 percent of observations 15 points or more above prediction.

While Figure 1.6 shows the best response data only for the HIGH treatment, it is a fair representation of the data as a whole. Table 1.7 shows the average effort of the controlling party and the corresponding average of the best response to beliefs. As can be seen, effort provision of the controlling party is above the average best response prediction in all treatments and authority structures, and in 7 of these 8 cases the difference is significant. Based on this data, we conclude:

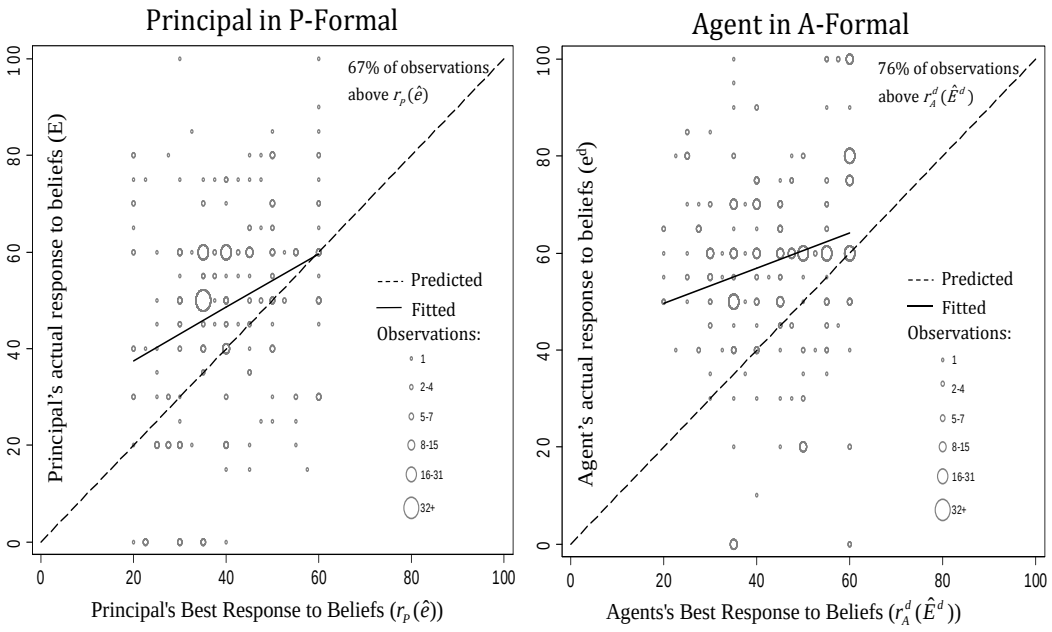



*Figure 1.6:* Controlling party: Actual effort vs. best response to beliefs (HIGH treatment)

*Table 1.7:* Comparison of effort provision of the controlling party to the best response to beliefs

| | **Principals in P-Formal** | | | **Agents in A-Formal** | | |
|---|---|---|---|---|---|---|
| | actual effort | | best response effort | actual effort | | best response effort |
| **PLOW** | 55.7 | | 53.7 | 68.1 | *** | 49.1 |
| **LOW** | 66.1 | *** | 54.6 | 68.3 | *** | 55.8 |
| **HIGH** | 48.2 | *** | 39.5 | 58.7 | *** | 45.3 |
| **PHIGH** | 58.2 | ** | 44.8 | 65.1 | ** | 56.2 |

Significance levels calculated using a Mann-Whitney-Wilcoxon test with beliefs and effort averaged to the individual level prior to estimation.
Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

**Result 6** *Controlling parties over provide effort relative to their best response to beliefs about the subordinate's effort.*

Result 6 suggests that having authority appears to have a motivational effect on the effort provision of the controlling parties. We next turn to beliefs. Since the effort of the two parties are strategic substitutes, deviations from the Nash Equilibrium prediction may partially be explained by pessimistic beliefs of controlling parties.

Table 1.8 compares actual beliefs to the Nash Equilibrium beliefs for all treatments and authority structures. As can be seen by comparing the first two columns, the principal's belief about agent effort in P-Formal authority is comparable to the Nash Equilibrium prediction. In fact, in three out of four cases (i.e. in PLOW, LOW and HIGH) the principals' effort expectation is above $e^{NE}$, but the deviation is not significant. Thus, pessimistic beliefs of the principal cannot contribute to the over provision of effort in these cases. The situation is somewhat different for A-Formal authority. Here, the controlling party (the agents) expected in all four treatments that the subordinate party will under provide effort relative to the Nash equilibrium. Thus, beliefs of the agents do account for some of the over provision of effort relative to the Nash Equilibrium prediction.

*Table 1.8:* Comparison of actual beliefs of the controlling party to the Nash equilibrium beliefs

| | **P-Formal** | | | **A-Formal** | | |
|---|---|---|---|---|---|---|
| | Nash prediction | | actual belief | Nash prediction | | actual belief |
| **PLOW** | 25 | | 30.7 | 35 | *** | 21.8 |
| **LOW** | 25 | | 26.8 | 25 | * | 20.9 |
| **HIGH** | 35 | | 36.5 | 35 | * | 29.4 |
| **PHIGH** | 35 | * | 30.5 | 25 | ** | 19.0 |

Significance levels calculated using a Mann-Whitney-Wilcoxon test with beliefs and effort averaged by individual prior to estimation.
Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

### *1.4.4 Exploring the subordinate parties' under provision of effort*

We next examine possible reasons for deviations from the Nash equilibrium on the part of the subordinates. In their case, a systematic under provision of effort relative to the best response may lead to a reduction of effort relative to the Nash equilibrium.

Figure 1.7 shows the relationship between the theoretical best response and the empirical response function in the case of the subordinates. As before, the 45° line represents the predicted best response function of the subordinate in response to beliefs about the effort of the controlling party while the filled line shows the empirical best response behavior from a simple linear regression. Points above the 45° line represent observations in which the subordinate over provides effort relative to the best response while points below the 45° line represents an under provision of effort.

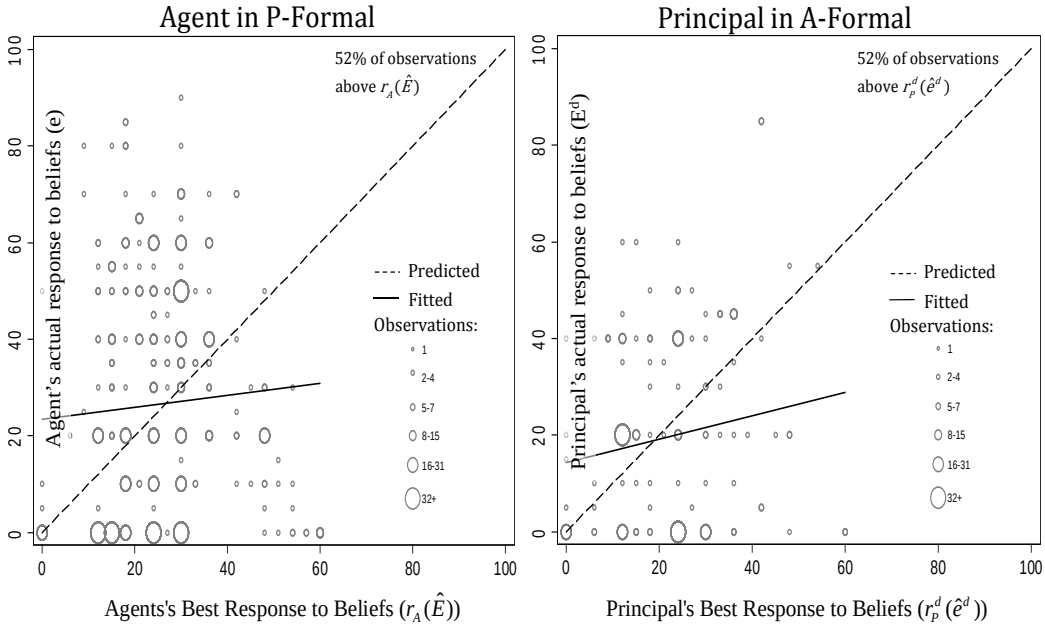



*Figure 1.7:* Subordinates: actual effort vs. best response to beliefs (HIGH treatment)

As can be seen in the left hand panel of the figure, the empirical response function is positive but flat, suggesting a relatively weak effort response to beliefs. Un-

like the controlling parties' efforts, which were clustered above the best response correspondence, effort provisions by subordinates are heterogeneous and roughly bimodal. 50 percent of individual choices are at or above the best response to beliefs for both agents in P-Formal authority and principals in A-Formal authority. In addition, a large number of individual choices is considerably below the best response. Interestingly, the heterogeneity of responses is not only present at the level of choices but also at the level of the individual. During the last five periods of the HIGH treatment 46 percent of the subordinates always underprovide effort and 39 percent of the individuals always overprovide effort relative to the best reply.

A particularly salient fact in Figure 1.7 is that a large number of subordinates put in zero effort, i.e., lack of control appears to have a strong demotivational effect for a large minority. Recall that the cost for effort is convex with the cost of increasing effort from 0 to 5 equalling $g_P(5) - g_P(0) = .06$ points. Since incremental effort is nearly costless, zero effort is predicted only in cases where the subordinate believes in an effort of 100 by the controlling party, which almost never occurred.

The heterogeneous response to the subordinate role appears to be a robust phenomenon across all four treatments. Across these treatments 58 percent of the subordinates always underprovide effort relative to the best reply during the last five periods and 24 percent always overprovide effort. Further evidence is shown in table 1.9, which reports the average effort of the subordinate, the average theoretical best response to beliefs, and the proportion of individuals who provide zero effort for each treatment and authority structure. As can be seen by comparing the first two columns of each treatment and authority structure, there is little difference between the actual effort and the theoretical best response to beliefs at the mean. The similarity in these two averages reflects the bimodal nature of subordinate effort provision where large outliers exist for both under and over provision of effort.

Looking at the third column of each row, however, the role of subordinate does appear to have a large demotivational effect in a large minority of individuals. In all conditions, at least 25 percent of individuals provide zero effort. In three of the eight conditions and authority structures, this group accounts for roughly 50 percent of observations. Based on these observations, we conclude:

**Result 7** *The response to the subordinate role is heterogeneous. While on average effort provision is close to the theoretical best response, there is a large group of subordinates who*

*provide zero effort, far below the optimal best response. For this large group, authority appears to have a strong demotivational effect. In addition, there is a smaller group of subordinates who systematically overprovide effort.*

*Table 1.9:* Comparison of effort of subordinates to their best response to beliefs

| | Agents in P-Formal | | | Principals in A-Formal | | |
|---|---|---|---|---|---|---|
| | actual effort | best reply to beliefs | percent zero | actual effort | best reply to beliefs | percent zero |
| **PLOW** | 22.8 | 21.1 | 39.0 | 16.5 | 18.4 | 36.7 |
| **LOW** | 14.3 * | 19.8 | 49.4 | 16.2 | 20.0 | 54.0 |
| **HIGH** | 26.5 | 24.5 | 28.5 | 19.6 | 21.9 | 36.8 |
| **PHIGH** | 17.3 | 18.4 | 50.3 | 20.7 | 21.7 | 36.7 |

Significance levels calculated using a Mann-Whitney-Wilcoxon test with beliefs and effort averaged to the individual level prior to estimation.
Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

Turning to beliefs, Table 1.10 shows the beliefs of the subordinate compared to the Nash Equilibrium beliefs. As can be seen, agents and principals have optimistic beliefs relative to the Nash equilibrium. As optimistic beliefs are expected to lead to a decrease in effort, beliefs may be contributing to the under provision of effort by the agent and the principals. However, as we noted in Figure 1.7, the empirical response function is much flatter than would be predicted by the best response. Whereas theory would predict an increase in effort of 6 point per 10 point reduction in beliefs, the empirical response to beliefs is significantly smaller. For agents, a 10 point reduction in beliefs about the controlling parties' effort only leads to a 1.2 point increase in effort.

Moreover, beliefs about controlling party effort need to be extremely high[20] to rationalize a subordinate's effort choice of zero. Since such extreme beliefs are rarely observed, best replies to beliefs cannot explain the large fraction of zero effort choices.

[20] for example, using a CRRA utility specification of the following form $U(x) = \frac{x^{1-\sigma}}{1-\sigma}$, an effort of 0 is only predicted if the belief in controlling party effort is 100 up to $\sigma = 8$. Hence, only for very extreme risk aversion, an effort of zero is predicted if the belief is 95, which is still very high and rarely observed.

*Table 1.10:* Comparison of actual beliefs of subordinates to the Nash equilibrium beliefs

| | **P-Formal** | | | **A-Formal** | | |
|---|---|---|---|---|---|---|
| | Nash prediction | | actual belief | Nash prediction | | actual belief |
| **PLOW** | 55 | *** | 64.8 | 45 | *** | 63.9 |
| **LOW** | 55 | *** | 66.9 | 55 | *** | 68.8 |
| **HIGH** | 45 | *** | 59.0 | 45 | *** | 61.2 |
| **PHIGH** | 45 | ** | 69.3 | 55 | *** | 62.5 |

Significance levels calculated using a Mann-Whitney-Wilcoxon test with beliefs and effort averaged by individual prior to estimation.
Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

### *1.4.5 The motivational and demotivational forces of authority: Ruling out alternative explanations*

Thus far we have seen that for both the principal and the agent deviations from best response behavior play an important role for departures from the Nash predictions. For all beliefs, a significant proportion of controlling parties provide effort which greatly exceeds the best response function leading to effort levels higher than predicted. Similarly, a significant proportion of subordinates provide zero effort despite the extremely small cost of low effort. This raises the question why subjects deviate from their best replies. Could it be, for example, that loss or risk aversion can account for the observed pattern of choices? Or, could the agents' effort choices be due to reciprocity or other forms of social preferences? Another possibility is that the deviations from best reply behavior are due to decision errors. In this section we show that all these hypotheses are very implausible explanations for the dual deviation of controlling parties' and subordinates' effort. In our view, this means that decision rights (and the lack of them) may have motivational consequences that go beyond the motives that have so far been considered by economists.

A common reason for deviations from risk neutral predictions in laboratory experiments is the potential existence of loss aversion. As we saw in section 4.2, loss aversion seems to play a considerable role in the principal's delegation decision and encourages them to keep control. However, as we show in Appendix C, loss aversion cannot explain the over provision of effort by the controlling parties. The

intuitive reason for this claim is as follows. For loss averse individuals, an increase in effort above the risk neutral optimum increases the magnitude of a potential loss which reduces utility. This follows from the fact that an increase in effort causes a sure increase in costs but as long as the possibility of success is below 1 the controlling parties' *ex post* payoff from unsuccessful search may not cover the effort cost. Thus, for reasonable amounts of loss aversion, optimal effort is decreasing in an individual's degree of loss aversion. In rare cases where an individual has extreme levels of loss aversion, an individual may prefer to guarantee a payoff rather than playing any lottery. For controlling parties with such extreme levels of loss aversion, providing maximal effort (which guarantees a payoff of 15) may be preferable to providing low effort and hoping for success by the subordinate. In these cases, loss aversion would predict a maximal effort level of 100.

Looking at both cases in combination, loss aversion cannot explain effort levels which are above the best response function but below an effort level of 100. As these are the observations which need to be rationalized in order to explain the over provision of effort by the controlling parties, loss aversion cannot explain our effort results. Regression analysis supports this interpretation. If we regress the controlling parties' effort on our measure of loss aversion (excluding effort choices of 100) we find a very small and insignificant effect ($p = 0.35$). Thus, loss aversion cannot explain the controlling parties' overprovision of effort.

At the typical stakes available in laboratory experiments risk aversion is generally not a plausible explanation of behavior. If one rationalizes risk averse behavior in laboratory experiments with a utility function that is concave in wealth one inevitably predicts totally unreasonable levels of risk aversion at higher stake levels (Rabin (2000); see also Appendix B). Thus, there is a strong a priori reason why risk aversion is unlikely to be a reason behind the controlling parties' overprovision of effort. However, for the sake of the argument, let us assume that individuals are risk averse, i.e., they have a striktly concave utility function. An increase in risk aversion thus reduces the utility of the highest payment relative to the utility of the lowest payment. For the cost parameters chosen in this experiment, diminished marginal utility of money directly reduces the marginal utility for a successful search relative to its marginal cost. As search is now less attractive, effort of a risk averse individual is predicted to be strictly below the risk neutral optimum. We illustrate this argument more formally in Appendix D. Thus, just as with loss

aversion, risk aversion cannot explain the over provision of effort by the controlling party.[21] Nor can risk and loss aversion explain the subordinates' choice of zero effort levels because effort costs are negligible at low effort levels.

If agents view the delegation of authority as a kind act they may over provide effort because of reciprocal motivations. Likewise, if they view a lack of delegation as an unkind act they may under provide effort relative to their best response. Thus, positive and negative reciprocity may, in principal, explain the agents' effort pattern. We tested for the impact of reciprocity motives by conducting an additional treatment in the HIGH condition in which the delegation decision was decided exogenously by the computer. In this HIGH RAND treatment, a virtual coin is flipped each period which determines whether control rights are kept by the principal or whether the principal is forced to delegate them. Since the agents know that the principals are forced to make a choice it is impossible to attribute kind or unkind intentions to the principal. If positive or negative reciprocity play a role, the agents' effort choices in the HIGH RAND condition will deviate from their choices in the HIGH condition. However, neither as a controlling party (Kolmogorov Smirnov test, p = .382) nor in the position of the subordinate party (Kolmogorov Smirnov test, p = .449) do the agents' effort choices differ in the two conditions, implying that reciprocity is unlikely to explain their effort pattern.

In all of our treatments, the controlling party over provides effort relative to her best response which directly increases the expected earnings of the subordinate. Thus, altruism on the part of the controlling parties could explain this pattern of effort. To control for this possibility we implemented an additional control treatment with the following features. Only one of the two subjects was given the ability to provide effort and to choose the project, but both parties were paid based on the active party's project choice. Thus, in this treatment the passive party never receives

[21] It is also interesting that risk loving preferences cannot explain the over provision of effort by the controlling parties. A risk loving subject will increase effort beyond the level that maximizes the expected monetary payoff if the subject can "buy" additional risk with this behavior. Since the spread of the payoffs is fixed by our payoff parameters (see Table 1) the subjects can only vary risk by varying the effort. The variance of the payoff that a subject faces is maximal at $E = 50$ and it is zero at $E = 0$ and $E = 1$. Thus, below and above $E = 50$ the variance of payoffs is lower than at $E = 50$. Therefore, a risk loving subject generally will not sacrifice expected payoff for the sake of increasing effort above $E = 50$. However, the overprovision of effort by the controlling parties is exactly characterized by the fact that a large number of effort observations are substantially above 50.

the decision right and never makes an effort choice but only collects her payoffs. We compare this treatment with the single player game (described at the beginning of Section 3.3) which is identical to the above control treatment except that no passive recipient exists. Thus in the additional control treatment social preferences can affect the active subject's effort while in the single player game social preferences cannot play a role. It turns out that the effort choices of the active party and the single player are indistinguishable (Kolmogorov Smirnov test, p = 0.43), indicating that social preferences do not affect effort.

Finally, we consider the possibility that decision errors might be responsible for the subjects' deviations from best response behavior. To examine this question we compute the quantal response equilibrium of the effort subgame. A basic idea of quantal response equilibrium (McKelvey and Palfrey (1995), Goeree and Holt (2001)) is (i) that subjects anticipate that their opponents make random errors and (ii) that they themselves play a best reply with errors to the other players' choices. In Appendix E we show that it is impossible to rationalize the overprovision of effort with such a model. This holds regardless of whether we assume small or large decision errors. In fact, a Kolmorov Smirnov test that compares the actual effort distribution with the distribution generated by the best fitting quantal response model clearly rejects the hypothesis that the two distributions are identical ($p < .001$).

## *1.5 Conclusion*

Authority and power permeate political, social and economic interactions. It is therefore important to understand the motivation and incentive effects of these forces. In this paper we tackle this question by using a novel experimental design. We find a strong behavioral bias among principals to retain authority against their pecuniary interests and often to the disadvantage of both the principal and the agent. We demonstrate that under delegation cannot be attributed to principal's beliefs, and that the individual and organizational welfare losses of this delegation bias are substantial. Our results suggest that individuals attribute a non-pecuniary value to the possession of authority. The positive valuation of authority per se is further endorsed by the finding that a principal's degree of loss aversion is highly predictive of his tendency to keep authority. Hence, there appear to be strong en-

dowment effects with regard to decision rights.

Our results also show that authority has effects on motivation that are not captured by the theoretical model. The fundamental trade-off between incentives and control, as modeled by Aghion and Tirole (1997), indeed exists; relative to the first best the subordinate provides too little effort, and the controlling party provides too much. However, the inefficiency generated by the incentive conflict is much greater than predicted by theory. The controlling parties provide significantly more effort and the subordinate parties provide significantly less relative to the Nash Equilibrium prediction. For controlling parties and a large fraction of subordinates, this is also true relative to the best response to beliefs. These deviations from the best response do not appear to be generated by reciprocity or other forms of social preferences, risk attitudes or decision errors, but rather point towards motivational effects of authority itself.

The psychological literature on power has put forward the idea that humans value power per se. However, to our knowledge, this hypothesis has not been shown to hold in an environment that controls for the pecuniary, risk, and social preferences of individuals in the power relationship. That humans value power and authority per se is important for economic models of organizations as well as for governance considerations in the political sciences because the reluctance to delegate can cause considerable welfare losses for organizations and, perhaps, even society. Further empirical studies of the determinants and consequences of power motivations may thus yield important insights. We believe that our empirical approach may prove useful in this respect.

Our experimental design also allows us to identify the consequences of authority on effort provision. Given that risk aversion, loss aversion, social preferences, or decision errors are very unlikely explanations for the observed deviations from best response behavior, we conjecture that humans not only value authority for non-instrumental reasons, but that authority may also have direct consequences on motivation. This is in line with the approach-inhibition theory of power put forward by Anderson, Gruenfeld and Keltner (2003). According to this theory the possession of power induces approach-related behaviors that tend to focus on the potential gains in risky situations, while a lack of power induces inhibition-related behaviors that tend to focus on the downside risk. In terms of our experiment this means that the controlling parties focus primarily on the potential gains which can

be reaped by a high effort while the subordinate parties primarily focus on the worst case, i.e., on the possibility that nobody knows the project valuations despite investments into effort. Reducing the effort to very low levels, the subordinate can improve the payoff in this worst case.

Given the importance of authority and power in the functioning of economic and political organizations we believe that the motivational biases revealed by our data should receive more attention. In particular, the result that a lack of authority does not demotivate all people strongly suggests that putting the right people into positions that lack authority is important. The development of tools for detecting this type of employee may thus be important in minimizing the cost associated with the (re)allocation of authority. Further experiments are necessary to better understand the sources and consequences of under delegation and the effect of decision rights on motivation.

## *1.6 Appendix*

### *1.6.A Additional Tables*

*Table 1.11:* Average effort levels vs. Nash predictions across treatments

| | **Controlling Party** | | | | **Subordinate** | | | |
|---|---|---|---|---|---|---|---|---|
| | **P-Formal** | | **A-Formal** | | **P-Formal** | | **A-Formal** | |
| | $E$ | $E^{NE}$ | $e^d$ | $e^{d^{NE}}$ | $e$ | $e^{NE}$ | $E^d$ | $E^{d^{NE}}$ |
| **PLOW** | 55.7 | 55 | 68.1*** | 45 | 22.8 | 25 | 16.5*** | 35 |
| **LOW** | 66.1*** | 55 | 68.3*** | 55 | 14.3*** | 25 | 16.2** | 25 |
| **HIGH** | 48.2* | 45 | 58.7*** | 45 | 26.5*** | 35 | 19.6*** | 35 |
| **PHIGH** | 58.2*** | 45 | 65.1** | 55 | 17.3*** | 35 | 20.7 | 25 |

Significance Levels for Wilcoxon Signed-Rank Tests against Nash with data averaged to the individual level prior to estimation.
Significance Levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

*Table 1.12:* Overall profit of principals and agents by treatment

| | **Principals** | | **Agents** | |
|---|---|---|---|---|
| | **Actual**[a] | **Predicted**[b] | **Actual**[a] | **Predicted**[b] |
| **PLOW** | 18.23 | *20.1* | 22.35 | *25.6* |
| **LOW** | 18.40 | *20.1* | 16.32 | *17.3* |
| **HIGH** | 20.69 | *24.0* | 21.13 | *23.3* |
| **PHIGH** | 21.89 | *25.6* | 16.83 | *20.1* |

[a] Actual earnings in treatment

[b] Predicted earnings with Nash equilibrium effort and delegation

### *1.6.B Measuring Loss Aversion*

In the main text of the paper, we interpret decisions made in the lottery task as being a result of loss aversion rather than risk aversion. This interpretation is based on Rabin's Calibration Theorem (Rabin (2000)) which shows that strictly concave utility of wealth is an implausible explanation for risk averse behavior over modest stakes. In this appendix we apply Rabin's calibration theorem to our lottery game. We show that if individuals have a globally concave utility function over wealth $w \in [0, \infty]$ and rejects gamble three of our lottery game — a coin flip in which the individual can either win CHF 6 or lose CHF 4 — then he or she will reject *any* coin flip in which she could lose CHF 30 no matter how large the positive prize that is associated with the coin flip. This is an implausibly high level of risk aversion while a reference dependent utility function that incorporates loss aversion can easily capture this behavior.

We proceed in four steps:

(i) We adopt the convention that, if indifferent, the individual rejects the coin flip. Rejecting the coin flip implies

$$0.5u(w+6) + 0.5u(w-4) \leq u(w)$$
$$u(w+6) - u(w) \leq u(w) - u(w-4)$$

It follows from concavity that $6[u(w+6) - u(w+5)] \leq u(w+6) - u(w)$ and $u(w) - u(w-4) \leq 4[u(w-3) - u(w-4)]$. Define $MU(x) = u(x) - u(x-1)$ as the marginal utility of the xth dollar. Putting the last three inequalities together, it follows that

$$MU(w+6) \leq \frac{2}{3} MU(w-4)$$

and, by concavity, that $MU(x+10) \leq \frac{2}{3} MU(x)$ for all $x > w-4$.

(ii) We now derive an upper bound on $u(\infty)$ . The concavity of $u()$ implies

$$u(w+10) \leq u(w) + 10MU(w)$$

Using the same logic,

$$\begin{aligned} u(w+20) &\leq u(w) + 10MU(w) + 10MU(w+10) \\ &\leq u(w) + 10MU(w)[1+\frac{2}{3}] \\ u(w+30) &\leq u(w) + 10MU(w)[1+\frac{2}{3}+\frac{2}{3}^2] \end{aligned}$$

and so on. Thus, we can develop a geometric series starting from $w$. Taking the limit, we obtain

$$u(\infty) \leq u(w) + 30MU(w)$$

(iii) Concavity implies $u(w-30) \leq u(w) - 30MU(w)$.

(iv) Using the results from step (ii) and (iii), we get an upper bound on the value of a coin flip where the individual would either lose CHF 30 or win an infinite amount:

$$0.5u(w-30) + 0.5u(\infty) \leq u(w)$$

This implies that the individual would reject the gamble. This concludes the proof.

### *1.6.C Loss Aversion and Effort*

In discussing the effort provision of a loss averse individual, we made the intuitive argument that loss aversion cannot explain the observed effort choices of the controlling party. This appendix shows that a controlling party who is loss averse will never choose effort which is above 60 but below 100.

Following Koszegi and Rabin (2006), we assume that subjects have a utility function of the following form:

$$v(x) = \begin{cases} x - R & \text{if } x \geq R \\ (1+\lambda)(x-R) & \text{if } x < R \end{cases}, \tag{1.16}$$

where $\lambda \geq 0$ denotes the degree of loss aversion and $R$ denotes the reference point. A natural reference point is $R = 10$, the value of project $P_0$ in each experiment. Recall that if subjects provide zero effort, they can always ensure a payoff of $P_0 = 10$ by choosing the known outside option. Also recall that $\hat{e}$ is the belief of the principal about the effort of the agent when she is the controlling party. We begin by proving the following:

**Lemma 1** *Let $E^*(\lambda, \hat{e})$ be a local maxima of the principal's utility maximization problem when she is the controlling party with loss aversion $\lambda$ and beliefs $\hat{e}$. Then $E^*(\lambda, \hat{e})$ is decreasing in loss aversion if $E^*(0, \hat{e}) < .65$.*

**Proof 1** *If $E < 0.65$, the cost of effort is below 10. Given the parameters in the authority game, this implies that losses relative to the reference point can only occur in the case that both the controlling party's and the subordinate's effort is unsuccessful. We use this fact to circumvent non-differentiability around the reference point by restricting analysis to this region. The optimization problem of the controlling party is*

$$\begin{aligned} \max_E U(E) = E(P_1 - R - g(E)) + (1-E)\hat{e}(P_2 - R - g(E)) \\ -(1+\lambda)(1-E)(1-\hat{e})(P_0 - R - g(E)). \end{aligned} \tag{1.17}$$

*By assumption $R = P_0$, which implies that the corresponding first order condition is:*

$$\begin{aligned} U'(E) = (\hat{P}_1 - g(E)) - Eg'(E) - \hat{e}(\hat{P}_2 - g(E)) - g'(E)\hat{e}(1-E) - \\ (1+\lambda)(1-\hat{e})[(g(E)) - g'(E)(1-E)] = 0. \end{aligned} \tag{1.18}$$

*Rearranging this equation and replacing $g'(E)$ and $g(E)$ and $\hat{P}_1$ with their values which were constant across treatments yields:*

$$U'(E) = -50E + 30 - \hat{e}\hat{P}_2 + 50\lambda(1-\hat{e})E\left[\frac{3}{2}E - 1\right] = 0. \tag{1.19}$$

*Writing* 1.19 *as an implicit function, the FOC is satisfied when:*

$$E = \frac{30 - \hat{e}\hat{P}_2}{50} + \lambda(1-\hat{e})E\left[\frac{3}{2}E - 1\right]. \tag{1.20}$$

*The last term is negative for $E \in \left[0, \frac{2}{3}\right]$ and $\lambda > 0$. Thus, effort is decreasing in $\lambda$ for all*

$E^*(0, \hat{e}) < .65$ *(our initial condition for the considered case).*

We now prove our main result:

**Proposition 1** *Effort of a loss averse individual will never be above 60 but below 100.*

**Proof 2** *Equation 1.19 can be rewritten as follows:*

$$U'(E) = 75\lambda(1-\hat{e})E^2 - 50[1+\lambda(1-\hat{e})]E + 30 - \hat{e}\hat{P}_2 = 0. \tag{1.21}$$

*Note that this equation is quadratic and thus has two roots. Taking the second derivative of $U$ with respect to $E$ we have:*

$$U''(E) = 150\lambda(1-\hat{e})E - 50[1+\lambda(1-\hat{e})]. \tag{1.22}$$

*Thus, there is a unique inflection point at $E = \frac{1}{3}\frac{1+\lambda(1-\hat{e})}{\lambda(1-\hat{e})}$. The second derivative is negative to the left of this reflection point and positive to the right of this inflection point.*

*By the properties of quadratic functions, $E$ is a local maxima/minima at:*

$$\frac{50[1+\lambda(1-\hat{e})] \pm \sqrt{Z(\lambda)}}{150\lambda(1-\hat{e})}, \tag{1.23}$$

*where $Z(\lambda) = 2500[1+\lambda(1-\hat{e})]^2 - 300\lambda(1-\hat{e})[30-\hat{e}\hat{P}_2]$. Also note that $Z(\lambda)$ is always greater than 0 so both roots exist. Comparing this to the inflection point, the left root is the local maximum. Next, using L'Hôpital's rule,*

$$E^*(0,\hat{e}) = \lim_{\lambda\to 0}\frac{50[1+\lambda(1-\hat{e})] - \sqrt{Z(\lambda)}}{150\lambda(1-\hat{e})} = \frac{[30-\hat{e}\hat{P}_2]}{50} \leq .6 \tag{1.24}$$

*By lemma 1, it follows that this unique local maximum is decreasing in loss aversion. As the unique local maximum is always below 60 and $E \in [0, 100]$, it follows that the global maxima are either below 60 or at the boundaries of $E = 0$ and $E = 100$.*

### *1.6.D Risk Aversion and Effort*

In discussing the effort provision of a risk averse individual, we made an informal argument as to why risk aversion and risk lovingness cannot account for the

effort provisions of the controlling party. This appendix provides numeric support for this argument for the case of CRRA utility.

Recall that a controlling party with belief $\hat{e}$ about the effort of the subordinate and concave utility function has expected utility of

$$\begin{aligned} U(E) = Eu(P_1 + w - g(E)) + \hat{e}(1-E)u(P_2 + w - g(E)) \\ +(1-\hat{e})(1-E)u(P_0 + w - g(E)) \end{aligned} \tag{1.25}$$

where $w$ is wealth, $P_1 = 40$, $P_2 \in \{35, 20\}$, $P_0 = 10$, $g(E) = 25E^2$, and $\hat{e} \in \{0, .05, \ldots, 1\}$. As can be seen by studying the arguments on the right hand side of this equation, increasing effort has two effects. First, an increase in effort increases the probability of winning the highest valued gamble which strictly increases utility. Second, increasing effort decreases the utility earned for each of the three possible outcomes. As this second effect necessarily depends on the marginal utility of three separate points, it is easy to construct cases in which locally, effort is increasing in risk aversion. Such local non-monotonicity makes analytic analysis both tedious and unenlightening, particularly for extremely concave utility or those which do not satisfy decreasing relative risk aversion.

As the decision problem of the controlling party is inherently discrete, we take a more direct approach to determining the potential effect of risk aversion on effort. Starting with common parameterized risk aversion utility functions such as CRRA and CARA, we find the risk aversion parameters which maximize effort and then compare these effort levels to the risk neutral baseline.

As with loss aversion, there is potential that an extremely risk averse controlling party will choose an effort of 100 and ensure themselves $P_1$. As a first step of the analysis, we start by finding the lowest $\sigma$ for which an individual with a CRRA utility will choose an effort of 1. Let

$$E(\sigma, \hat{e}) = arg \max_E Eu(P_1 + \hat{e}(1-E)u(P_2 + w - g(E)) + (1-\hat{e})(1-E)u(P_0 + w - g(E)) \tag{1.26}$$

be the optimal effort of an individual with CRRA utility of the form $u(x) = \frac{x^{1-\sigma}}{1-\sigma}$ where $w \geq 16$ so that utility is always well defined. Next, define $\sigma_1$ to be the smallest risk aversion parameter such that $E(\sigma_1, \hat{e}) = 1$. It can be shown analytically that

$E(\sigma, \hat{e}) = 1$ for all $\sigma > \sigma_1$ and thus that $\sigma_1$ is a sufficient statistic for the parameter space where full effort is predicted.

Our interest in risk aversion lies in being able to predict effort levels above the risk neutral prediction but below an effort of 1. It follows that the next step of our analysis is to look at the maximum possible effort which can be predicted for all $\sigma \in [-\infty, \sigma_1)$. Let

$$\sigma^*(\hat{e}) = arg \max_{\sigma \in [-\infty, \sigma_1)} E(\sigma, \hat{e}) \tag{1.27}$$

and define $E(\sigma^*(\hat{e}), \hat{e})$ as the effort level which corresponds to $\sigma^*(\hat{e})$. For all initial beliefs, we find $E(\sigma^*(\hat{e}), \hat{e})$ and compare this to $E(0, \hat{e})$, the effort predicted when an individual is risk neutral.

*Table 1.13:* Maximum effort predicted by risk aversion (LOW Treatment)

*Low Treatment*

| $\hat{e}$ | $\sigma^*(\hat{e})$ | $\sigma_1$ | $E(\sigma^*, \hat{e})$ | $E(0, \hat{e})$ |
|---|---|---|---|---|
| 0 | $-0.7 - 0.6$ | 1.2 | 60 | 60 |
| 10 | $-0.3 - 0.3$ | 1.4 | 60 | 60 |
| 20 | $-1.3 - 0.7$ | 1.6 | 55 | 55 |
| 30 | $-0.9 - 0.5$ | 2.0 | 55 | 55 |
| 40 | $-2 - 0.9$ | 2.5 | 50 | 50 |
| 50 | $-1.8 - 0.6$ | 3.2 | 50 | 50 |

*High Treatment*

| $\hat{e}$ | $\sigma^*(\hat{e})$ | $\sigma_1$ | $E(\sigma^*, \hat{e})$ | $E(0, \hat{e})$ |
|---|---|---|---|---|
| 0 | $-0.7 - 0.6$ | 1.2 | 60 | 60 |
| 10 | $-.9 - 0.7$ | 1.6 | 55 | 55 |
| 20 | $-1.1 - 0.7$ | 2.2 | 50 | 50 |
| 30 | $-1.2 - 0.8$ | 2.9 | 45 | 45 |
| 40 | $-1.4 - 0.9$ | 3.8 | 40 | 40 |
| 50 | $-1.5 - 1.3$ | 5.0 | 35 | 35 |

Table 1.13 reports $\sigma^*(\hat{e})$, $\sigma_1$, as well as $E(\sigma^*(\hat{e}), \hat{e})$ and $E(0, \hat{e})$ for initial beliefs $\hat{e}$ in intervals of 10. As can be seen, $\sigma^*(\hat{e}) < 0$ for all initial beliefs revealing that an individual who is slightly risk loving will provide the highest effort. As can be seen in the last two columns of the table, however, the increase in effort for these individuals is not large enough to alter the effort predictions.

As we typically are most interested in small amounts of risk aversion, it is useful

to also look at $\sigma$ in the domain of $[0, \sigma_1)$. For all wealth and beliefs, it is the case that effort is maximal in this domain when $\sigma = 0$.

Just as with loss aversion, effort provision under risk aversion has a difficult time explaining effort levels above the risk neutral prediction. For all $w \geq 16$, all beliefs $\hat{e}$, and using both CRRA and CARA utility, it is never the case that $E(\sigma^*(\hat{e}), \hat{e}) - E(0, \hat{e}) > 5$. As 50 percent of our data lies 15 points above the risk neutral prediction, we cannot rationalize the over provision of effort by the controlling party with risk.

### *1.6.E The impact of decision errors on effort choices*

In this appendix we examine whether decision errors are a plausible explanation for subjects' deviations from best response effort levels. For this purpose, we construct the quantal response equilibrium (QRE) of the subgame in which principals and agents choose effort levels, and look at the noise parameter $\gamma$ which best describes our data using a maximum likelihood criterion. The first step in this approach is to develop a logit choice model where the probability of selecting an effort level is determined by the ratio of the actual value of a choice relative to all potential alternatives. Let

$$p(E) = \frac{\exp(\gamma EV_P(E|p(e)))}{\sum_E \exp(\gamma EV_P(E|p(e)))} \tag{1.28}$$

be the probability that effort level $E$ is chosen given the equilibrium choice distribution of the other party. The parameter $\gamma$ controls the probability that an individual selects a suboptimal effort choice. As $\gamma \to \infty$ the QRE approaches the original unique Nash equilibria of the theoretical model. As $\gamma \to 0$, the choices of both parties goes toward the uniform distribution with equal probability weight on each outcome.

Across all treatments, the noise parameter $\gamma$ which best describes our data is between 0.2 and .45, close to what would be predicted if all strategies were chosen randomly. The failure of the QRE to predict our results are best seen in Figure 1.8, which plots QRE predicted effort against the empirical effort distribution for principals who kept control in the HIGH treatment. As can be seen by looking at the three QRE distributions plotted for various $\gamma$ levels, the QRE model has a

density function which is centered at the best response and which flattens as $\gamma$ decreases. Note also, that since the QRE distributions are normally distributed, adding density to parts of the distribution which are away from the best response requires a reduction of the noise parameter $\gamma$.

Figure 1.8 shows that the peak of the empirical distribution is to the right of the best response with a relatively tight distribution of effort levels. In order for the QRE model to add mass to the region which contains this empirical peak, $\gamma$ must decrease. The low $\gamma$ parameter is thus not informative of the data itself but merely reflects the fact that the QRE model predicts too low effort levels. As can be seen by comparing the QRE's predicted distribution against the empirical distribution, the two distributions are highly dissimilar. A similar argument can be made with regard to the subordinates' effort level. Since the mean of the distribution of effort predicted by the QRE is substantially above zero, the QRE model cannot explain the high frequency of zero effort choices. Therefore, taken together, QRE decision errors cannot explain the systematic deviations from best response effort levels.

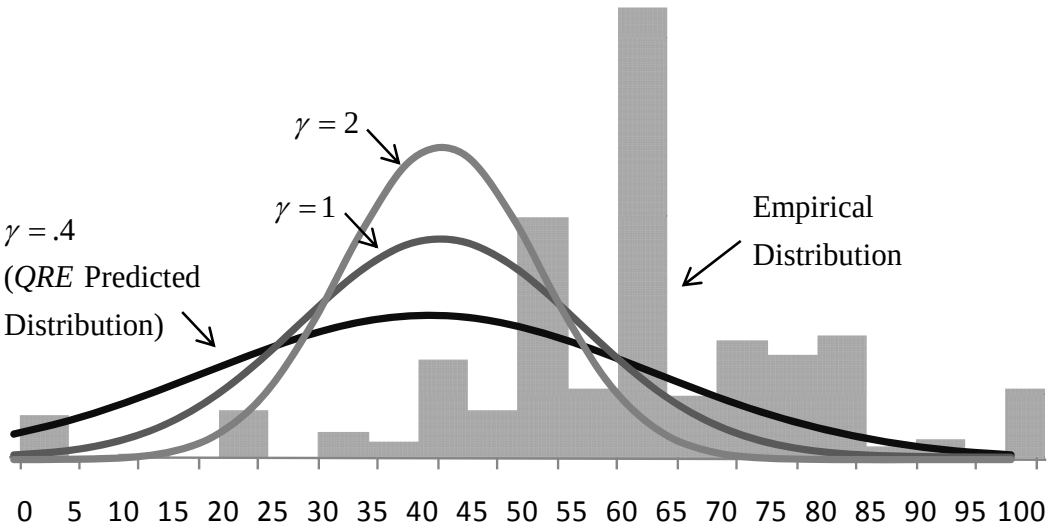



*Figure 1.8:* Comparison of the QRE predicted effort distribution and the empirical effort distribution.

The distribution of effort predicted under QRE (shown by the smooth density lines) does not correctly predict the peak of the empirical effort distribution. In order to better fit the actual data (depicted by the histogram), the noise parameter $\gamma$ must decrease. The best fitting QRE has a $\gamma = .4$ which is close to the uniform distribution. This distribution is a poor representation of the true distribution which has significantly lower variance and retains a bell curve shape. A Kolmogorov-Smirnov test rejects that they are the same distribution at the $p = .001$ level.

# 2. THE VALUE OF AUTHORITY

## *Chapter Overview*

While the incentive effects of authority within organizations have been studied extensively in economics, researchers from other social sciences have suggested that authority not only has instrumental value, but might be intrinsically valuable. We develop a theoretical and experimental framework which incorporates the possibility that authority has intrinsic value and enables us to identify this value empirically. Our data show that humans intrinsically value authority and that the intrinsic value component affects the authority delegation trade-off consistently across subjects and across different games. The intrinsic utility component of authority has important consequences for organizations, such as inefficient delegation of authority, a tendency for empire building, empowerment of employees, and it can be an obstacle to mergers and acquisitions.

## *2.1 Introduction*

This paper tests the hypothesis that authority is intrinsically valuable. Authority is defined as the right to take decisions that have consequences for oneself and other parties within the organization (Simon, 1951). The distribution of authority in organizations establishes a hierarchy, which has important consequences for incentives and for organizational efficiency (see, for example, Aghion and Tirole (1997), Dessein (2002), Alonso, Dessein, and Matouschek (2008), Athey and Roberts (2001), and Baker, Gibbons, and Murphy (1999)). It is therefore important to understand the motives of individuals to acquire and hold on to authority. So far, economists focussed on the incentive effects of authority and regarded authority as an instrument that can be valuable because it enables the extraction of rents, the choice of favorable actions or the adjustment of risk and uncertainty according to one's preference.

Authority as it is defined in this paper gives an individual influence over others, since actions taken in organizations usually affect the outcomes of other individuals. Therefore, the notion of authority in organizations neatly fits into standard political science definitions of power.[1] It may be important to consider the power aspect of authority because psychologists have long argued that there might be more to power than the extrinsic benefits that result from its exercise. For example, the concept of power motivation (McClelland, 1975) postulates that "Humans have a 'need for power' where power connotes an internal urge to influence and control other people." Moreover, the concepts of self-determination and self-efficacy are both closely related to authority and have long been considered as potential intrinsic sources of utility (Deci, 1981; Bandura, 1997).

However, the abovementioned psychological literature to our knowledge does not distinguish clearly between intrinsic and extrinsic factors that may affect utility. The economic literature on the other hand has so far ignored potential intrinsic utility aspects of authority. It therefore remains an open question whether authority is simply a tool that allows individuals to achieve higher utility by using it to influ-

[1] See, for example Giddens (1985): "Power in its highly generalized sense means 'transformative capacity', the capability to intervene in a given set of events so as in some way to alter them." (The Nation-State and Violence). Another definition is given by Bachrach and Baratz (1970): "Of course power is exercised when A participates in the making of decisions that affect B." Further definitions of power can be found in Polsby (1963) or Lukes (2005).

ence processes to their own advantage, or whether it additionally has an intrinsic utility component. With field data, it is difficult to precisely measure a potential intrinsic utility component, because the costs and benefits associated with having or not having authority are private information of the individual. Extrinsic and intrinsic components of utility are therefore not perfectly separable. Moreover, the utility function of the individual is unobservable and usually only one position within the authority relationship is observed (either an individual has authority or is a subordinate), so nothing can be learned about the counterfactual case. Given these limitations of field data, experimental evidence is useful to shed light on this question.

This paper develops a theoretical framework which incorporates the possibility that authority has intrinsic value for individuals, and we use experimental methods to test whether individuals indeed assign intrinsic value to authority. A laboratory experiment is ideally suited to study this question because it gives us control over the benefits and costs to each individual. It also allows us to study both, the situation in which an individual has authority and the situation in which it is the subordinate, such that we can draw conclusions with regard to the utility received in both cases.

In our experiment, a principal and an agent can implement a project. The project can be implemented in two different variants and there is a conflict of interest with regard to which variant should be chosen. One variant is favoured by the principal, the other by the agent. The party with authority can choose the variant. The party with authority can also choose the effort, which determines the probability of successful implementation. Effort is costly and the party with authority has to bear this cost.[2]

Initially, authority is given to the principal. The principal can keep authority or choose to delegate authority to the agent. Our experiment is concerned with the principal's willingness to delegate authority to the agent. Intuitively, the principal should delegate authority if his utility in case of delegation is at least as large as

[2] We purposefully introduced a conflict of interest with regard to the variant choice. Some political scientists view conflict between parties as essential for authority to be meaningful. For example, Ball (1976) writes: "when we say that someone has power or is powerful we are assigning responsibility to a human agent or agency for bringing (or failing to bring) about certain outcomes that impinge upon the interests of other human beings."

his utility if he keeps authority. However, the outcomes in case of delegation will depend on actions taken by the agent. Therefore expected utility in case of delegation depends on beliefs as well as risk and ambiguity preferences. In order to control for the principal's preferences and beliefs, we use an approach that elicits the conditions that make the principal indifferent between keeping and delegating authority. The principal can choose a minimal effort requirement for the agent, conditionally on which authority is delegated. Authority is delegated only if the agent chooses an effort which is at or above the stated requirement. Otherwise, the principal keeps authority. At the same time, the principal chooses his own effort for the case that the agent does not fulfill the requirement. This delegation mechanism serves as an elicitation method of the principal's point of indifference between keeping and delegating authority, and it is not meant to resemble delegation mechanisms as they are observed in real organizations. It enables us to observe the principal's utility maximizing behavior when he keeps authority, as well as an effort requirement for the agent that, if exactly chosen, makes the principal indifferent between keeping and delegating authority. If the agent chooses an effort level above the minimal requirement, the principal strictly prefers to delegate authority, because project success becomes more likely. Once the effort and variant decisions are made, payoffs in the authority game are solely determined based on the probability of successful project implementation and the associated payoffs and costs. Hence, there is an implied lottery that determines the ultimate outcomes for the principal and the agent. We label the implied lottery in the case in which the principal keeps authority as "the authority lottery," and the implied lottery in the case of delegated authority when the agent exactly chooses the minimal effort requirement as "the subordinate lottery."

The revealed indifference between the authority lottery and the subordinate lottery can be used to test the null hypothesis that authority has no intrinsic effect on utility. In a second part of the experiment, we elicit certainty equivalents of lotteries that are identical in any aspect to the authority lottery and the subordinate lottery from the authority game. However, these lotteries are presented to the principals as pure lotteries, i. e. completely outside the context of the authority game. Therefore, preferences for authority cannot play a role in the evaluation of these lotteries because they do not arise in the context of exercising authority. The principals are simply confronted with lotteries and an incentive compatible mechanism is used to

elicit their valuations for these lotteries. If authority indeed has no intrinsic effect on utility, we should observe no systematic differences in the certainty equivalents of these lotteries. If, however, authority is intrinsically valuable to individuals, then the additional utility the principal associates with authority will lead him to demand compensation for delegating it away. This means that when comparing the pure lotteries that are monetarily equivalent to (1) the subordinate lottery vs. (2) the authority lottery, he will place higher value on the former.

Our main finding is that principals have an intrinsic value of authority, which cannot be explained by the monetary consequences of the authority allocation. Principals assign significantly *larger* certainty equivalents to the pure lottery that is identical to the subordinate lottery compared to the pure lottery that is identical to the authority lottery. On average, when evaluated in terms of certain income, this difference amounts to 14.2 percent of the overall value of the lottery. Given that the principal reveals indifference between the two lotteries in the authority game, the observed difference in certainty equivalents must be due to an intrinsic value component that is not represented in the pure lotteries. The intrinsic value component must be such that it positively affects utility when keeping authority relative to being the subordinate in order to restore the initial indifference.

While our main result establishes the existence of an intrinsic value of authority, it is important to check the robustness of this result on an individual level. If intrinsic value of authority is indeed a stable component of individual preferences, it should affect individuals consistently across different situations that involve an authority relationship. In our experiment, principals had to make decisions on the delegation of authority in 12 games that differed with regard to the payoffs at the different project variants. Changes in payoffs imply that the optimal effort as well as the optimal minimal agent effort requirement change. Estimating Cronbach alpha, a concept that allows to assess the extent to which our different games measure the same latent variable, reveals that the intrinsic value of authority is measured very consistently across games ($\alpha = 0.81$), which lends support to the hypothesis that the intrinsic value of authority is based on a stable individual preference for authority.

Additional evidence that authority is intrinsically valuable may be obtained by considering individual loss aversion, i.e. the tendency of losses to loom larger than equally sized gains. There is evidence that the valuation of owned goods is affected

by loss aversion (Knetsch, 1995), because more loss averse individuals demand a larger compensation for the loss of a good than less loss averse individuals. If authority is intrinsically valuable, we might also observe such an effect in our data. In our experiment, the subjects were randomly assigned the role of the principal, i.e., they were randomly endowed with authority. Thus, if there is intrinsic value of authority, then subjects whose preferences exhibit more loss aversion should demand a larger compensation for the delegation of authority. In a separate experiment we measure subject's loss aversion and indeed find a positive correlation between a subject's loss aversion and the intrinsic value assigned to authority. Subjects with a degree of loss aversion above the median on average have a 37 percent larger intrinsic value of authority than subjects with a degree of loss aversion below the median.

Our paper contributes to the understanding of the motivational consequences of authority. We provide evidence that individuals have an intrinsic value of authority, an insight that has so far been neglected in economics and that has, to our knowledge, not been shown empirically in other social science literatures. These insights have important consequences for the analysis of authority relationships within organizations. Individual incentives to efficiently delegate authority within organizations might be severely reduced, which implies a rationale for models that assume that individuals maximize discretionary budgets or power in organizations (Niskanen, 1971). It creates a distortion in the efficient delegation of authority to subordinates. Indeed, Fehr, Herz, and Wilkening (2010) find evidence that principals delegate too little which results in considerable monetary losses for the organization in an experimental setting.[3] Given that the optimal assignment of authority can have large implications for the efficiency of an organization (Aghion and Tirole, 1997), it can be harmful if the authority allocation is distorted due to individual intrinsic benefits from keeping authority. Hence, organizational efficiency can be significantly reduced due to underdelegation of authority.[4] It is therefore important to

[3] Dominguez-Martinez, Sloof, and von Siemens (2010) also find suggestive evidence that principals have a preference for control in a principal-agent monitoring task.

[4] Given that we argue that authority is intrinsically valuable, this value should obviously be included in an analysis of efficiency of the organization. However, authority was randomly assigned in our experiment. Hence it is reasonable to assume that on average agents and principals intrinsically value authority equally. There might be some selection that principals who intrinsically value

think about mechanisms that bring about the optimal allocation of authority within organizations and account for potential distortions that stem from the fact that the interests of the party making the delegation decision can be severely misaligned from the organization's interest due to intrinsic value of authority.

Intrinsic value of authority is also discussed in the corporate finance literature in the form of private benefits of control rights (Dyck and Zingales, 2004). This literature suggests that intrinsic value of authority can have effects on organizational growth and transformation. For example, there is evidence that is consistent with CEO's trading power for premium in merger negotiations (see Wulf (2004) and Hartzell, Ofek, and Yermack (2004)) and there is suggestive evidence that mergers can fail because of dispute over the authority allocation in the merged company. For example, in 1998 a planned merger between Glaxo-Wellcome and SmithKline Beecham, which would have been the largest merger ever at that time, failed because the top executives of the merging firms were unable to agree on the division of authority in the merged entity.[5] The merger failed despite consensus that synergies between the two firms would have been large.[6] The notion that social factors - like the intrinsic value of authority - may be important determinants of merger success and failure is indeed discussed widely by practitioners and observers of mergers and acquisitions (Lipin, 1996). Intrinsic value of authority is thus one aspect that helps understand how exactly social factors affect organizational change, and which role they may play in the evolution and restructuring of organizations.

Another application of the intrinsic value of authority is worker empowerment. Managerial scientists regard empowerment as an important tool of employee motivation. Thomas and Velthouse (1990) identify four cognitions which are the basis of worker empowerment: Sense of impact, competence, meaningfulness, and choice. Clearly, these cognitions do not only refer to instrumental aspects of power, but

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authority particularly highly are more likely to keep authority. Nonetheless, due to the original random assignment and no sorting possibility of the agents, it is reasonable to conjecture that the inefficiencies can remain large even when accounting for the intrinsic value of authority.

[5] Hartzell, Ofek, and Yermack (2004) provide further evidence of this kind, for example how the proposed acquisition of Texaco Inc. by Chevron Corp. initially fell through because Chevron's CEO "was not willing to share power with" his Texaco counterpart.

[6] This particular case of merger failure has become known as the "clash of the egos." The firms finally merged two years later, after the SmithKline CEO retired in 1999.

also to intrinsic aspects. The empowerment literature postulates that delegation of authority serves the purpose to raise an agent's utility, independent of the consequences of authority. This implies that the delegation of authority can help relax participation constraints. Suggestive evidence in favour of this hypothesis has previously been found in studies of individuals who follow career paths that give them more authority in what they do. Hamilton (2000) shows that entrepreneurs effectively forego earnings for their self-employment, which is also true for scientists (see Stern (2004)). Our results suggest that intrinsic value of authority is a potential explanation for these differences and they provide a rationale why worker empowerment affects workers beyond the pecuniary incentive effects of authority.

Finally, the clear distinction between intrinsic and extrinsic impact factors on individual utility in our paper lends credibility to theories in social psychology that power itself, as well as elements of power like increased self-determination and increased self-efficacy, are intrinsically valuable. Even in the field of economic philosophy the notion that attributes of power may be intrinsically valuable is discussed, for example in the capabilities approach developed by Amartya Sen and Martha Nussbaum (see for example Sen and Nussbaum (1993) and Nussbaum (2000)).[7] Given the prevalence of interest in the effects of power and authority, the empirical evidence provided in this paper should be taken into account not only in organizational economics, but in other social science disciplines as well.

The remainder of the paper is structured as follows. Section 2.2 details our experimental design. In Section 2.3, we present theoretical predictions and a theoretical framework that incorporates the possibility that authority has intrinsic value. Section 2.4 reports the results of our experiment, and Section 2.5 concludes.

## *2.2 Experimental Design*

Our experiment is designed to measure an individual's intrinsic value of authority, i.e. the component of the total willingness to pay for authority retention that is independent of the monetary consequences. A clean measurement of this value requires a design that involves two separate experiments. The first experi-

[7] Martha Nussbaum writes: "The central capabilities are not just instrumental for further pursuits: they are held to have value in themselves, in making the life that includes them fully human" (Nussbaum (2000)).

ment is an authority game and the second is a lottery experiment. Subjects participated in both experiments in a single session. The authority game was always played first. Subjects read instructions and had to answer control questions to guarantee that the instructions were understood. Instructions for the lottery experiment were only handed out after the authority game was finished, and subjects did not know the content of the second experiment beforehand. Again, subjects had to complete control questions to make sure that the instructions for the lottery experiment were understood. Section 2.2.1 explains the authority game and Section 2.2.2 explains the lottery experiment in detail. Procedural details are given in Section 2.2.3.

### *2.2.1 The Authority Game*

The basis of our experimental design is a principal-agent game, in which a principal (she) and an agent (he) are organized in a hierarchical structure and must decide to implement a project.

The project can be implemented in one of two variants: variant $A$ or variant $B$. Each variant generates a private monetary benefit of $P_A$ or $P_B$ for the principal and of $A_A$ or $A_B$ for the agent if the project is implemented successfully. If the project implementation is unsuccessful, the principal and the agent receive a known outside value of $P_0$ and $A_0$ respectively. The principal always prefers variant $A$ over variant $B$ ($P_A > P_B > P_0$), and the agent always prefers variant $B$ over variant $A$ ($A_B > A_A > A_0$), and independent of the variant, a successful implementation is always preferred to the outside option. One party is given authority, which is equivalent to the right to choose a project variant and the right to choose an effort level to successfully implement the project. This party can select the effort in increments of 1 from $\{0, 1, \ldots, 99, 100\}$. This effort corresponds to the probability that the project is implemented successfully. Effort choices are made in private and effort has an associated cost generated via a quadratic cost function. The cost is borne by the party who chooses the effort. Costs are identical for the principal and the agent. Project payoffs and cost functions are common knowledge. The cost functions are given by: $C_P(E) = \frac{E^2}{100}$ and $C_A(e) = \frac{e^2}{100}$, where $E$ is the principal's effort choice and $e$ is the agent's effort choice.[8]

[8] The cost of effort is presented to subjects in a table where each possible effort and its associated

The game is played in 5 stages, which are illustrated in Figure 2.1. In the first stage of the game, the principal has authority but can choose to delegate it to the agent. In case of no delegation, the principal gets to choose the variant and the implementation effort. In case of delegation, the agent gets to choose the variant and the implementation effort. The delegation decision is not implemented as a binary choice, but as a conditional choice. The principal can condition the delegation of authority on the agent's effort in case the agent receives authority. Precisely, the principal can choose a minimal agent effort ($MAE$) requirement, conditionally on which the delegation of authority is implemented. If the agent chooses an effort level equal to or above the requirement, authority is delegated to him. Otherwise, the principal keeps authority.[9] If, for example, the principal determined an $MAE$ of 60, and the agent chose an effort of 40, authority was not delegated and the principal kept authority.[10]

The second and the third stage are implemented using the strategy method. Both parties determine their variant and effort choice in case they have authority.[11] Finally, in stage 4 and 5, given the minimal effort requirement and the actual agent effort, the delegation decision is determined, and according to the choices made in stage 2 and 3 the project variant is implemented. A random process determines the success or failure of the project implementation, and payoffs are made accordingly.

This experimental procedure allows us to elicit five different variables: the principal's effort and variant choice, the minimal agent effort requirement of the principal conditional on which he delegates authority and the agent's effort and variant choice.

The authority game was repeated for 12 rounds. Subjects remained in the role of

cost are displayed. In addition, the instructions contained a graph displaying the cost function (see appendix B for further details).

[9] The $MAE$ could not be made conditional on the variant choice of the agent. The agent was always free to choose the variant he preferred. In 98.1 percent of the cases, this was variant B.

[10] Only the party who eventually has authority has to bear the cost of his own effort. If, for example, the principal decides not to delegate authority to the agent, the agent does not have to bear the cost associated with his choice of $e$, since the agent never gets to actually implement the project.

[11] It is important to note that the agent is not aware that his effort choice can in fact affect the delegation decision. We deliberately let the agent choose conditional on authority being delegated to him, in order to avoid strategic considerations on the principal as well as the agent's side when making their effort and minimal agent effort requirement choices.

the principal or the agent throughout the experiment. The twelve rounds differed with regard to the payoffs that could be achieved at variant A and variant B of the project. The cost functions were constant across rounds. Therefore, in every round a different authority game was played. We chose different parameterizations in order to test the robustness of a potential result across different games. Table 2.1 gives an overview of the payoffs in each game.

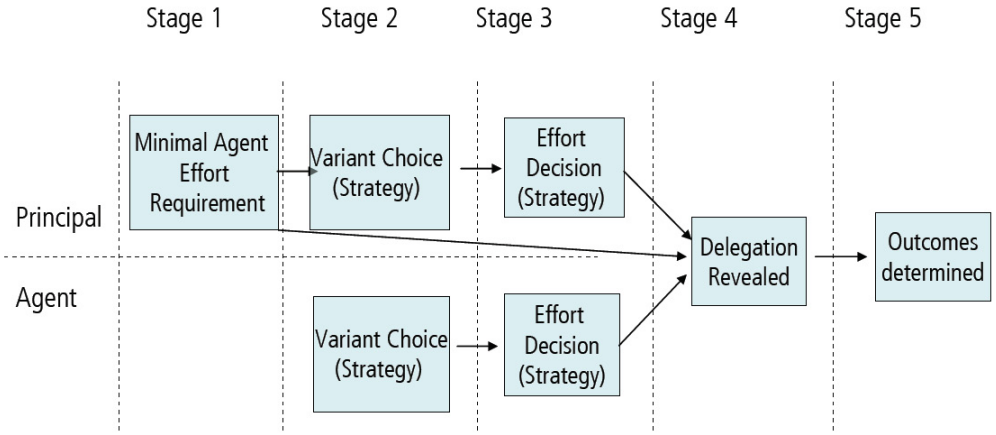



*Figure 2.1:* The Stage Game

Subjects were informed that in a new round they would be matched with another randomly chosen partner. No feedback was given to the subjects after each round. Only at the very end of a session (after the lottery experiment), outcomes and payoffs were determined. The order of game 1 to 12 was randomized across sessions.

### *2.2.2 Lotteries*

After the authority game was played, all subjects participated in a second experiment. In the second experiment, principals were presented 24 pure lotteries and were asked to state certainty equivalents for these lotteries. Each principal received a different set of lotteries, determined by the principal's own choices in the authority game. 12 lotteries were designed such that they were exactly equal to

| | Project successful | | | | Project unsuccessful | |
|---|---|---|---|---|---|---|
| | Variant A | | Variant B | | both variants | |
| | Principal | Agent | Principal | Agent | Principal | Agent |
| **Game 1** | 200 | 130 | 130 | 250 | 100 | 100 |
| **Game 2** | 200 | 150 | 150 | 250 | 100 | 100 |
| **Game 3** | 200 | 175 | 175 | 250 | 100 | 100 |
| **Game 4** | 200 | 130 | 130 | 200 | 100 | 100 |
| **Game 5** | 200 | 150 | 150 | 200 | 100 | 100 |
| **Game 6** | 200 | 175 | 175 | 200 | 100 | 100 |
| **Game 7** | 180 | 130 | 130 | 180 | 100 | 100 |
| **Game 8** | 180 | 150 | 150 | 180 | 100 | 100 |
| **Game 9** | 180 | 175 | 175 | 180 | 100 | 100 |
| **Game 10** | 180 | 130 | 130 | 200 | 100 | 100 |
| **Game 11** | 180 | 150 | 150 | 200 | 100 | 100 |
| **Game 12** | 180 | 175 | 175 | 200 | 100 | 100 |

*Table 2.1:* Project Payoffs in each game

the 12 authority lotteries, one for each round. The payoffs for these lotteries were determined based on the principal's own choices of $E$ and the project variant if she kept authority in the authority game. The other 12 lotteries were designed such that they were exactly identical to the 12 subordinate lotteries, one for each round. Again, the payoffs for these lotteries were determined based on the principal's own choice of $MAE$ and project variant B, in case of delegation of authority to the agent. The principals were offered each of these 24 lotteries in a randomized order.[12]

For example, assume that a principal chose an own effort of $E = 50$ (with an associated effort cost of 25) and variant A, and chose a minimum required effort for the agent of $MAE = 40$ (with an associated effort cost of 16) in game 1 of the authority game (see Table 2.1). This implies that the principal implicitly faces two lotteries with the following payoffs in the authority game:

- Authority-Lottery:
  - The principal earns $200 - 25 = 175$ points with 50% probability and $100 - 25 = 75$ points with 50% probability.

[12] The agents were also offered lotteries which match the consequences of choices made by principals in the authority game. Since we are mainly interested in the principal's assessment of these lotteries, we restrict further discussion to the principals.

  - The agent earns 130 points with 50% probability and 100 points with 50% probability.

- Subordinate Lottery:

  - The principal earns 130 points with 40% probability and 100 points with 60% probability.
  - The agent earns $250 - 16 = 234$ points with 40% probability and $100 - 16 = 84$ points with 60% probability.

In the lottery experiment, the principal is confronted with exactly these lotteries, but they are presented outside of a delegation and effort choice framework. The principal is simply referred to as "you", and the agent is a "random other participant", whom participants were randomly matched with and who received the specified payoff.

To elicit the certainty equivalents, we used an incentive compatible mechanism first introduced by Becker, DeGroot, and Marschak (1963). Subjects had to choose how much in terms of certain payoffs they demand in order to be willing to accept the certain payment instead of playing the presented lottery. In case the certain payment was accepted, the random other participant received 100 points. A random mechanism then determined the certain payment that was actually offered to the principal. In case the actually offered certain payment was at or above the stated certainty equivalent, the principal received the actual certain payment and the other party received 100 points. The lottery was not played in this case. In case the actual certain payment was below the stated certainty equivalent, the lottery was played.

### *2.2.3 Procedures*

We conducted two sessions with a total of 72 subjects. Our subject pool consisted primarily of students at Zurich University and the Swiss Federal Institute of Technology in Zurich.[13] The experiments took place in April and May 2010. Experiments were computerized using the software z-tree (Fischbacher, 2007). Payment

[13] Subjects were drawn from a database of volunteers using ORSEE (Greiner, 2004).

was given for one randomly drawn round of the authority game and for four randomly drawn lotteries.[14] On average, an experimental session lasted 2.5 hours with an average payment of 45.8 CHF ($52.00 at the time of the experiment), including a 10 CHF show-up fee. A translation of the instructions is in appendix B.

## *2.3 Theory*

We first analyze the authority game in detail. As a benchmark, we initially assume risk-neutral and selfish preferences. Later, we relax assumptions, because our experiment is designed such that subjects directly reveal their preferences. Therefore we need to impose very little structure on individual utility functions to test our main hypothesis.

### *2.3.1 Theoretical analysis under the assumption of individual material payoff maximization*

If the principal keeps authority, she has an incentive to implement her preferred variant and she chooses effort such that expected material payoff is maximized:

$$\max_E E \cdot P_A + (1 - E) \cdot P_0 - C_P(E) \tag{2.1}$$

Hence, effort is chosen such that marginal costs equal marginal revenue:

$$P_A - P_0 = C'_P(E) \tag{2.2}$$

Similarly, if the principal delegates authority, the agent has an incentive to choose his preferred variant and chooses e to maximize his expected material payoff from the project:

$$\max_e e \cdot A_B + (1 - e) \cdot A_0 - C_A(e) \tag{2.3}$$

[14] Each subject chose certainty equivalents in 24 lotteries. 2 of these lotteries were paid. This guarantees that the expected value (in Swiss Francs) of one point in the lottery experiment is equal to the expected value (in Swiss Francs) of one point in the authority game. In addition, each subject also took the role of the "other party" in the lottery treatment. For every lottery, the subject is randomly assigned to another subject. Two of the 24 lotteries were chosen and paid out according to the choices of that other subject.

Again, expected material payoff is maximized when marginal costs equal marginal revenue:

$$A_B - A_0 = C'_A(e) \tag{2.4}$$

Let $E^*$ and $e^*$ denote the solutions to the maximization problems of the principal and the agent, respectively. When making the delegation decision, the principal has to contrast his expected material payoff when keeping authority and choosing $E^*$ to his expected material payoff when delegating authority and having the agent choose $e^*$. Hence, delegation is optimal if

$$E^* \cdot P_A + (1 - E^*) \cdot P_0 - C_P(E^*) \leq e^* \cdot P_B + (1 - e^*) \cdot P_0 \tag{2.5}$$

The optimality of delegation will therefore depend on the values attached to variant A and variant B, as well as the agent's optimal effort choice. In our experiment, however, the principal could choose a minimal agent effort requirement ($MAE$), such that he is only delegating authority if $e \geq MAE$.[15] The principal should therefore choose $MAE$ such that

$$E^* \cdot P_A + (1 - E^*) \cdot P_0 - C_P(E^*) = MAE \cdot P_B + (1 - MAE) \cdot P_0 \tag{2.6}$$

It follows that

$$MAE^* = \frac{E^* \cdot (P_A - P_0) - C_P(E^*)}{P_B - P_0} \tag{2.7}$$

The twelve games are designed such that the predictions with regard to optimal principal effort, optimal agent effort and the required minimal agent effort differed. The games also lead to different equilibrium predictions with regard to delegation. Table 2.1 displays the payoffs at each variant in each game. Table 2.2 summarizes the predictions for $e$, $E$ and $MAE$ in each game based on the analysis in this subsection. It also gives the equilibrium prediction with respect to delegation.

[15] Notice that the expected material payoff of the principal in case of delegation is strictly increasing in $e$.

| | $E^*$ | $e^*$ | $MAE^*$ | Delegation |
|---|---|---|---|---|
| **Game 1** | 50 | 75 | 85 | No |
| **Game 2** | 50 | 75 | 50 | Yes |
| **Game 3** | 50 | 75 | 35 | Yes |
| **Game 4** | 50 | 50 | 85 | No |
| **Game 5** | 50 | 50 | 50 | Indifferent |
| **Game 6** | 50 | 50 | 35 | Yes |
| **Game 7** | 40 | 40 | 50 | No |
| **Game 8** | 40 | 40 | 35 | Yes |
| **Game 9** | 40 | 40 | 25 | Yes |
| **Game 10** | 40 | 50 | 50 | Indifferent |
| **Game 11** | 40 | 50 | 35 | Yes |
| **Game 12** | 40 | 50 | 25 | Yes |

*Table 2.2:* Predicted effort levels and equilibrium delegation under the assumption of individual expected material payoff maximization

### *2.3.2 Generalization of the theoretical analysis*

What happens if we relax the assumptions imposed on the utility function of the principal? Obviously, the optimal effort level and the required minimal agent effort depend on the preferences of the individual, which we are unable to observe directly. Risk-attitudes may affect expected utility and therefore the principal's optimal choice of $E$ and $MAE$, since the authority game is a risky decision situation. Moreover, ambiguity aversion may affect the utility received after delegation, because the agent's exact effort choice is unknown. Given that two parties are affected, social preferences could also be a determinant of the effort and the delegation decision. These factors are very likely to cause deviations from the risk-neutral, selfish predictions presented in Section 2.3.1. In our theoretical framework, which is laid out in detail below, we therefore allow that risk, ambiguity and social preferences affect utility. Most importantly, we also extend the utility framework by allowing that utility is intrinsically affected by authority, which introduces our main hypothesis.

Let the utility function of a subject over sure amounts of money be written as $u(x, y, A)$, where $x$ denotes own payoff, $y$ denotes the payoff of another party, and $A$ denotes the position of the individual within the authority relationship. $A = 1$ implies that an individual has authority, $A = 0$ denotes the case in which the

individual is the subordinate, and the case of authority neutrality is denoted as $A = \varnothing$. This refers to the case in which outcomes are not the result of someone's action, but simply given to the individual.[16]

In our experiment, there is uncertainty with regard to outcomes. We assume that principals are expected utility maximizers and the von Neumann-Morgenstern expected utility function is denoted by $U(L, A)$, where $L$ denotes the lottery that reflects the potential outcomes of all parties involved as well as the outcome probabilities.

The goal of the theoretical analysis is to analyze the optimal delegation decision and the development of an individual measure of the intrinsic value of authority. Principals derive utility from a lottery over monetary outcomes, and potentially from their position in the authority relationship. In our experiment, the lotteries over monetary outcomes result from the effort and minimal effort requirement choices of the principal. The key feature of our experimental design is that we can directly control for individual preferences, because the choices of $E$ and $MAE$ reveal the principal's point of indifference between keeping authority and delegating authority.

Let $x = \begin{pmatrix} P_A - C_P(E) \\ P_0 - C_P(E) \end{pmatrix}$ denote the vector of monetary outcomes for the principal and $y = \begin{pmatrix} A_A \\ A_0 \end{pmatrix}$ denotes a vector of monetary outcomes for the agent in the authority lottery.[17] $x' = \begin{pmatrix} P_B \\ P_0 \end{pmatrix}$ denotes the vector of monetary outcomes for the principal and $y' = \begin{pmatrix} A_B - C_A(MAE) \\ A_0 - C_A(MAE) \end{pmatrix}$ denotes a vector of monetary outcomes for the agent in the subordinate lottery.[18] $E$ and $MAE$ denote the probability of success

[16] The authority neutral case applies in our lottery treatment. Each subject evaluates a lottery that is given to him. It is not the consequence of another parties actions. Therefore, we call it authority-neutral.

[17] We assumed here that the principal chose his preferred variant (variant A). In case the principal chose variant B, $x$ and $y$ would be $x = \begin{pmatrix} P_B - C_P(E) \\ P_0 - C_P(E) \end{pmatrix}$ and $y = \begin{pmatrix} A_B \\ A_0 \end{pmatrix}$.

[18] Here, we always assume that the agent chooses his preferred variant B. Of course, the agent was also free to choose variant A. Again, we assume that this will never hurt the principal, because it

in the respective situations.

Remember that the agent is not restricted to the choice of $MAE$. Authority is delegated to the agent whenever he chooses $e \geq MAE$. Therefore, in order for our analysis to hold, we need to impose some structure on the underlying utility function. We assume that $\frac{\partial U(x',y',MAE|A=0)}{\partial MAE} \geq 0$. This implies that it does not hurt the principal if the agent invests an effort that is higher than the minimal requirement. We regard this assumption as weak and very reasonable, because the project success becomes more likely. Social preferences do not reverse this effect since the agent reveals that he is maximizing his own utility at some other effort level, making the principal monetarily better off at the same time. This implies that $U(x', y', MAE|A = 0)$ is the minimal utility that will be realized in all potential realizations of the authority game in case of delegation. The ambiguity that still exists with regard to the agent's actions can therefore not hurt the principal. If anything, he will be better off than in the subordinate lottery in which $MAE$ is chosen by the agent. Hence, even extreme forms of ambiguity aversion imply that the overall utility after delegation is at least as large as $U(x', y', MAE|A = 0)$. Therefore, it is an additional important feature of our design that differences in certainty equivalents cannot be attributed to ambiguity aversion. Given the monotonicity of principal utility in $e$, it is therefore optimal for the principal to choose $MAE$ such that the utility after delegation is at least equal to the utility when the principal keeps authority and implements the project herself. Therefore, the following condition holds:

$$U(x, y, E|A = 1) = U(x', y', MAE|A = 0) \tag{2.8}$$

We are interested in testing the null hypothesis that authority has no impact on individual utility. If this is the case, the utility function is independent of $A$, and we can write:

$$U(x, y, E|A = 1) = U(x, y, E|A = 0) = U(x, y, E|A = \varnothing) = U(x, y, E) \tag{2.9}$$

makes herself monetarily better of and it is the utility maximizing choice of the agent at the same time.

For all 24 lotteries, there exist certainty equivalents which yield the same utility as the lottery. We can therefore write:

$$U(x, y, E) = u(CE(x, y, E)) \quad (2.10)$$

$$U(x', y', MAE) = u(CE(x', y', MAE)) \quad (2.11)$$

Hence, if authority has no impact on individual utility, the following condition follows from equation 2.8:

$$u(CE(x, y, E)) = u(CE(x', y', MAE)) \quad (2.12)$$

$$CE(x, y, E) = CE(x', y', MAE) \quad (2.13)$$

Thus, if the authority relationship has no intrinsic effect on utility, the principal should be indifferent between the pure lottery that is exactly identical to the authority-lottery and pure lottery that is exactly identical to the subordinate-lottery. In other words, in each of the 12 games, the pairs of certainty equivalents relating to these two lotteries have to be identical. If we find significant differences in these certainty equivalents, authority has an intrinsic impact on utility in the authority game. If, for example, the certainty equivalents of the pure lotteries that are identical to the subordinate lotteries are significantly larger than the certainty equivalents of the pure lotteries that are identical to the authority lotteries, there must have been some other component that positively affected utility in the authority lottery relative to the subordinate lottery, such that the principal was initially indifferent between the authority lottery and the subordinate lottery.

**Hypothesis 1** *There is no difference in certainty equivalents of the two pure lotteries that are identical in terms of payoffs to the authority lottery and the subordinate lottery from the authority game. Therefore, authority has no intrinsic impact on utility.*

### *2.3.3 Introducing a monetary measure of the intrinsic value of authority*

To analyze the potential intrinsic impact of authority on utility further, we define a measure of the individual intrinsic utility derived from authority. Intuitively, the measure captures how much an individual demands in form of certain payoffs in order to be compensated for the loss of the intrinsic value of authority.

The expected utility associated with the authority lottery is given by $U(x, y, E|A = 1)$. The certainty equivalent that yields the same utility when the principal has authority is given by $CE(x, y, E|A = 1)$. It follows that[19]

$$U(x, y, E|A = 1) = u\Big[CE(x, y, E|A = 1)|A = 1\Big]. \tag{2.14}$$

We now define the monetary value $MV_{A=1}$. This value captures the intrinsic effect on utility derived from having authority, relative to the authority-neutral benchmark.
$CE(x, y, E|A = \oslash)$ denotes the certainty equivalent of the pure lottery that is exactly identical to the authority lottery, but not the consequence of an authority delegation game. This is precisely the certainty equivalent that we measure in the lottery experiment. This certainty equivalent differs in an important aspect from $CE(x, y, E|A = 1)$, since it abstracts from the potential intrinsic impact of authority on utility. To account for this potential difference, we introduce the value $MV_{A=1}$. This value captures the compensation in terms of certain income which is required to keep utility constant when moving from the authority lottery, that involves having authority, to the pure lottery that exactly mirrors the authority lottery, but is presented in an authority-neutral environment. Or, in other words, $MV_{A=1}$ is the difference in value between the certainty equivalent that we actually measure, and the certainty equivalent that reflects the utility in the authority game when the authority lottery has been chosen. it therefore follows that

$$u\Big[CE(x, y, E|A = 1)|A = 1\Big] = u\Big[CE(x, y, E|A = \varnothing) + MV_{A=1}|A = \varnothing\Big]. \tag{2.15}$$

We can repeat this exercise for the expected utility of the principal in the subor-

[19] When the principal chooses the certainty equivalent, the agent gets a payoff of 100 points. Hence, the correctly specified utility function when the principal chooses the certainty equivalent is given by $u\Big[CE(x, y, E|A = 1)|A = 1; 100\Big]$, where the first entry denotes the payoff to the principal and the second entry denotes the payoff to the agent. Since the payoff to the agent is always 100 whenever the certainty equivalent is chosen, we omit this payoff in the notation in the subsequent discussion.

dinate lottery. There, utility can be written as

$$\begin{aligned} U(x', y', MAE|A = 0) &= u\Big[CE(x', y', MAE|A = 0)|A = 0\Big] \\ &= u\Big[CE(x', y', MAE|A = \varnothing) + MV_{A=0}|A = \varnothing\Big] \end{aligned} \tag{2.16}$$

In equation 2.16, $MV_{A=0}$ is therefore defined as the compensation in terms of certain income which is required to keep utility constant when moving from the subordinate lottery that involves not having authority to the pure lottery that is identical to the subordinate lottery, but not the consequence of an authority delegation game.

What is the overall intrinsic value of authority? The principal's choice is between having authority and being the subordinate. The relevant measure for the intrinsic value of authority is therefore the difference between $MV_{A=1}$ and $MV_{A=0}$.[20] We know by revealed preference that

$$U(x, y, E|A = 1) = U(x', y', MAE|A = 0) \tag{2.17}$$

Given the transformations made in equations 2.15 and 2.16, this implies that

$$\begin{aligned} u\Big[CE(x, y, E|A = \varnothing) + MV_{A=1}|A = \varnothing\Big] = \\ u\Big[CE(x', y', MAE|A = \varnothing) + MV_{A=0}|A = \varnothing\Big] \end{aligned} \tag{2.18}$$

From equation 2.18 follows that

$$CE(x, y, E|A = \varnothing) + MV_{A=1} = CE(x', y', MAE|A = \varnothing) + MV_{A=0} \tag{2.19}$$

$$MV_{A=1} - MV_{A=0} = CE(x', y', MAE|A = \varnothing) - CE(x, y, E|A = \varnothing) \tag{2.20}$$

Hence, we can use the difference in certainty equivalents of the pure lottery that is identical to the subordinate lottery and pure lottery that is identical to the authority lottery as an individual measure of the utility compensation required for

[20] In models in the spirit of Aghion and Tirole (1997) it is indeed always the case that giving up authority implies being put in the subordinate position. Our experiment does not allow us to measure $MV_{A=1}$ and $MV_{A=0}$ separately. However, this may be desirable in future research. For example, an entrepreneur who faces the decision to sell his company or a CEO who faces a merger will potentially loose authority but is unlikely to face subordinacy as a consequence as well.

the loss of the intrinsic value of authority. Therefore, we are able to directly observe a measure of the intrinsic value of authority from our data. We will refer to the term $MV_{A=1} - MV_{A=0}$ as the "monetary value of authority."

### *2.3.4 Measurement of loss aversion*

In the experiment described in Section 2.2, the principals are endowed with the right to choose the effort and the project. There is evidence that the valuation of owned goods is affected by an individual's loss aversion (Knetsch, 1989; Kahneman, Knetsch, and Thaler, 1990). Thus, if principals intrinsically value authority, loss aversion can play a role here because more loss averse principals may be more reluctant to give up authority than principals who are less loss averse. In order to better understand the potential individual heterogeneity in the intrinsic value of authority, we therefore measured subjects loss aversion with a lottery choice task. Each subject was presented with the opportunity to participate in six different lotteries, each having the following form:[21]

> Win CHF 6 with probability $\frac{1}{2}$, lose CHF X with probability $\frac{1}{2}$. If subjects reject the lottery they receive CHF 0.

The six lotteries varied in the amount $X$ that could be lost, where $X$ took on the values $X \in \{2, 3, 4, 5, 6, 7\}$. One of the six gambles was randomly selected and paid. These lotteries enable us to construct individual measures of loss aversion. The amount $X$ at which a subject starts rejecting the lottery is an indicator of a subjects' loss aversion.[22] For example, a subject that rejects all lotteries with a potential loss

[21] This experiment to elicit individual loss aversion is adopted from Fehr and Goette (2007).

[22] One might think that rejection of these lotteries may also be compatible with risk aversion. However, Rabin (2000) shows that a theory of risk averse behavior based on the assumption of diminishing marginal utility of lifetime income implies that people essentially must be risk neutral for low-stake gambles like these lotteries. Intuitively, this follows from the fact that risk-averse behavior for low-stake gambles implies ridiculously high levels of risk aversion for slightly higher, but still moderate, stake levels. Such unreasonably high levels of risk aversion can be safely ruled out. For example, we show in appendix A that if one assumes that the rejection of the lottery with $X = 4$ is driven by diminishing marginal utility of lifetime income, then the subject will also reject a lottery where one can lose \$30 with probability $\frac{1}{2}$ and win any price with probability $\frac{1}{2}$. Thus, there is no finite prize that induces this subject to accept a 50-percent chance of losing \$30.

of $X > 3$ is classified as more loss averse than a subject that only rejects all lotteries with a potential loss of $X > 5$.[23]

Eliciting a measure of a principal's loss aversion enables us to analyze whether the existing empirical evidence that loss aversion can affect the valuation of owned goods can possibly be extended to less tangible domains like authority. If we indeed find a correlation between the intrinsic value of authority and loss aversion, it would suggest that authority is indeed treated in similar ways as goods, which in turn would lend additional support to the hypothesis that it is intrinsically valuable. It also points out one important aspect of preferences that is of particular importance for efficiency in organizations, since it would imply that a more loss averse principal is more likely to cause inefficiencies due to his delegation decisions. We therefore test the following hypothesis:

**Hypothesis 2** *More loss averse principals demand a larger compensation in terms of certain income for the loss of the intrinsic value of authority.*

## *2.4 Results*

### *2.4.1 Is there an intrinsic value of authority?*

Our theoretical framework generates predictions with regard to the intrinsic impact of authority on utility. If authority has no intrinsic influence on utility, we should observe that principals value the lottery that is identical to the authority lottery and the lottery that is identical to the subordinate lottery equally. Empirically, we do not find that this is the case in our experiment:

**Result 1** *Principals intrinsically value authority. The principals value the pure lotteries that are in all monetary aspects identical to the subordinate lotteries significantly higher than the pure lotteries that are in all monetary aspects identical to the authority lotteries. On average, the difference in certainty equivalents is 14.2%. Hence, evaluated in certain income, the intrinsic value of authority accounts for 14.2% of the overall generated value to the principal in the authority game.*

[23] 68 out of 72 subjects who participated in the lottery task have a unique switching point.

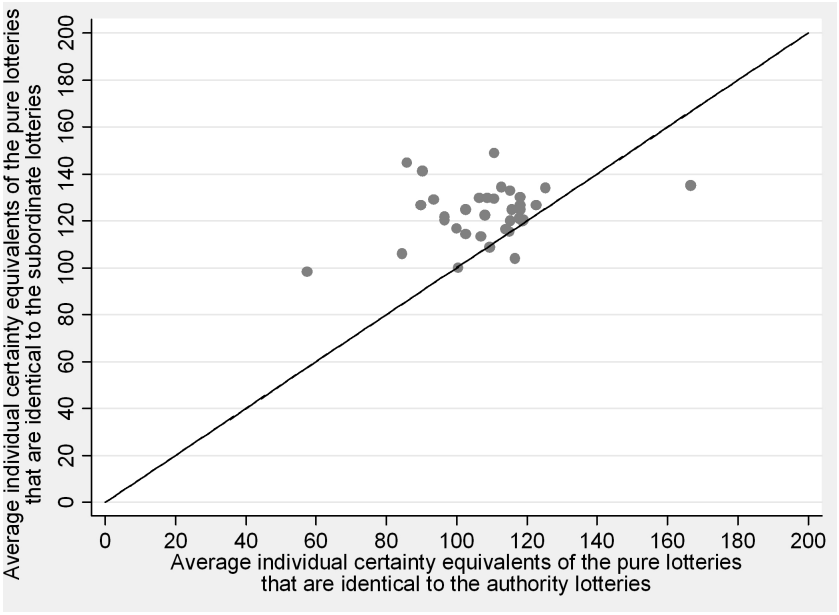



*Figure 2.2:* Average individual certainty equivalents of the pure lotteries that are identical to the authority lotteries and identical to the subordinate lotteries (in points).

Figure 2.2 shows the average certainty equivalents principals assigned to the pure lotteries that are identical to the authority lotteries ($CE(x, y, E|A = \varnothing)$) on the horizontal axis and the average certainty equivalents assigned to the pure lotteries that are identical to the subordinate lotteries ($CE(x', y', MAE|A = \varnothing)$) on the vertical axis. If principals derive no intrinsic utility from authority ($MV_{A=1} - MV_{A=0} = 0$), the average certainty equivalents of these lotteries should be equal. However, it can immediately be seen that the vast majority of observations lie above the 45° line. The average individual certainty equivalent of the pure lotteries that are identical to the subordinate lotteries is 123.3 points, and the average individual certainty equivalent for the pure lotteries that are identical to the authority lotteries is 108.6 points. The hypothesis that the average individual certainty equivalents are equal can be rejected ($p = 0.00$, Wilcoxon signed-rank test). On average, principals assign higher certainty equivalents to the pure lotteries that are identical to the subordinate lotteries, which in turn implies that principals derive a higher utility from the monetary consequences of the subordinate lotteries than the authority lotteries. Remember from the theory and design section that the principal revealed being in-

different between delegating authority if the agent chooses $MAE$, and choosing $E$ when he keeps authority herself. In the authority game, decisions were embedded in an authority-relationship, which is not the case in the lottery treatment. The difference in certainty equivalents assigned to the lotteries implies that the authority relationship indeed affects utility. Given that the certainty equivalents of the lotteries that are identical to the subordinate lotteries are significantly higher than the certainty equivalents of the lotteries that are identical to the authority lotteries, principals have an intrinsic value of authority.

### *2.4.2 Heterogeneity across different authority games*

Remember that the experiment consisted of 12 different games which varied with regard to the payoffs of the principal and the agent at variant A and variant B. We can use these different games to test the robustness of our result with regard to the game parameters.

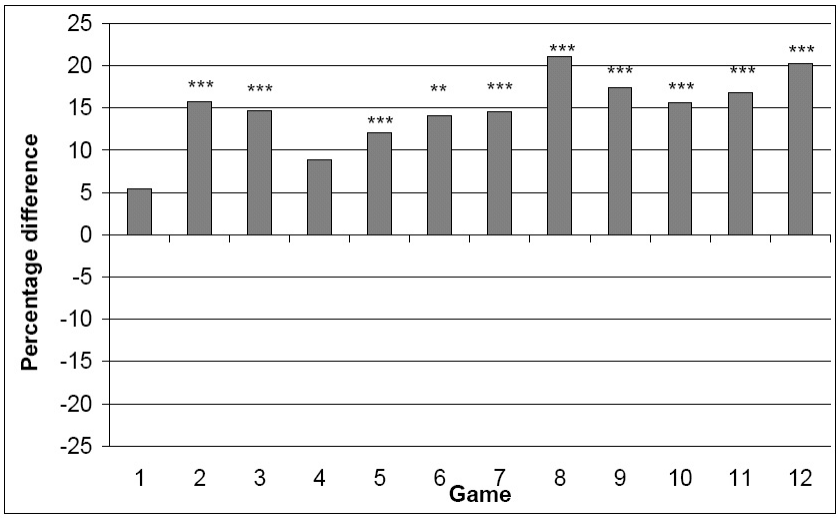



*Figure 2.3:* Average percentage difference between the certainty equivalent of pure lotteries that are identical to the subordinate lotteries and the certainty equivalent of the pure lotteries that are identical to the authority lotteries, sorted by authority game. Significance levels calculated using Wilcoxon signed-rank tests: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Figure 2.3 displays the average percentage difference in certainty equivalents in all 12 authority games. The pure lotteries that are identical to the subordinate

lotteries are consistently valued higher than the pure lotteries that are identical to the authority lotteries across the different games. The intrinsic value of authority is positive in all 12 games, and significantly different from 0 in 10 out of 12.

The fact that authority is intrinsically valued in all 12 games demonstrates the robustness of our result. Nonetheless we observe differences in the intrinsic value assigned to authority across the 12 games. Therefore, before we turn to an analysis of the individual determinants of the intrinsic value of authority, it is useful to analyze potential determinants of these differences. Remember that the principal reveals his preference through her choice of $E$ and $MAE$. It therefore may be informative to analyze the determinants of these choices. Table 2.3 reports regressions of the principal's effort choices ($E$) and of the principal's minimal effort requirements for the agent ($MAE$) on parameters of the game. Observations are only included if the principal chose variant A, since incentives are very different if variant B is chosen.[24] As a benchmark, we include choice predictions from Section 2.3.1 in the regression analysis.

Column (1) of Table 2.3 reports a regression of the principal's effort choice ($E$) on the optimal effort choice calculated under the assumption of individual expected material payoff maximization ($E^*$). If principals are risk-neutral and perfectly respond to monetary incentives in the game, neglecting the payoff of the other party, the constant in regression (1) should be zero and the coefficient on $E^*$ should equal 1. It can be seen that the constant is greater than zero, but not significantly so. Moreover, the coefficient on $E^*$ is 0.78, which is smaller than 1, but again not significantly so (p=0.56). Taking the expected individual material payoff maximizer from Section 2.3.1 as the benchmark , we can conclude that principals react to monetary incentives very much like it is predicted in our baseline model. Column (2) reports an identical regression of the minimal agent effort requirement ($MAE$) on the optimal choice of $MAE$. Again, $MAE^*$ takes on the optimal value of $MAE$ in case the principal is risk neutral and does not take into account the other party's payoff (except for the incentive effect on the agent's effort).[25] If the principals in our sample had such preferences, the constant should be 0 and the coefficient on $MAE^*$ should be 1. We can observe that the constant significantly deviates from 0 and takes on

[24] Variant B was chosen in 6.8% of the cases.

[25] $MAE^*$ is calculated according to equation 2.7 in Section 2.3.

*Table 2.3:* Determinants of Effort Choices

| | (1) $E$ | (2) $MAE$ | (3) $E$ | (4) $MAE$ |
|---|---|---|---|---|
| $E^*$ | 0.780** | | | |
| | (0.373) | | | |
| $MAE^*$ | | 0.624*** | | |
| | | (0.076) | | |
| P.'s payoff at var. A ($P_A$) | | | 0.371* | 0.543*** |
| | | | (0.195) | (0.135) |
| A.'s payoff at var. B ($A_B$) | | | 0.011 | 0.092* |
| | | | (0.026) | (0.047) |
| $P_B$ | | | | –0.604*** |
| | | | | (0.075) |
| $A_A$ | | | –0.167*** | |
| | | | (0.038) | |
| Constant | 20.739 | 18.441*** | 8.301 | 16.860 |
| | (17.064) | (4.837) | (36.561) | (21.029) |
| Adj. $R^2$ | 0.037 | 0.173 | 0.056 | 0.204 |
| Observations | 400 | 400 | 400 | 400 |

Significance levels: * p<0.1, ** p<0.05, *** p<0.01
Robust standard errors in parentheses, clustered by the individual.
$P_B$ denotes the principal's payoff at variant B.
$A_A$ denotes the agent's payoff at variant A.
$E^*$ denotes the optimal principal effort choice reported in Table 2.2.
$MAE^*$ denotes the optimal minimal effort requirement reported in Table 2.2.
Only principals who chose variant A are included in the regression.

a positive value. The coefficient on $MAE^*$ is 0.63, which is significantly smaller than 1 (p=0.00). Hence, from our baseline model viewpoint, principals demand too much from the agent when the optimal requirement should be small, and they demand not enough when the requirement should be high.

Columns (3) and (4) analyze how the payoffs of the principal and the agent at variant A and variant B affect effort choices. It can be seen that $P_A$ significantly and positively affects the principal's effort choice, which confirms the observation from column (1). While $A_B$ is largely irrelevant, as it should be, interestingly $A_A$ also seems to matter as a determinant of effort. An increase in the agent's payoff causes the principal to decrease his own effort. Evidently, payoff comparisons between the parties seem to matter for effort choice. Column (4) reports the effect of payoff on the minimal agent requirement. An increase in $P_A$ leads to a significant increase

in the minimal agent requirement, which confirms that principals require a larger compensation the more they give up when delegating authority. At the same time, the required compensation is lowered if $P_B$ increases. Table 2.3 therefore shows that principal's reactions to changes in incentives are directionally consistent with standard economic theory, and that the delegation trade-off was well understood.

### *2.4.3 Heterogeneity in the intrinsic value of authority across individuals*

In this subsection, we analyze how consistent our measure of intrinsic value of authority is across games, and whether we can identify individual determinants of the intrinsic value of authority. In Section 2.3, we introduced an individual measure for the intrinsic value of authority. Figure 2.4 shows a histogram which depicts the mean intrinsic value of authority, averaged by the individual.

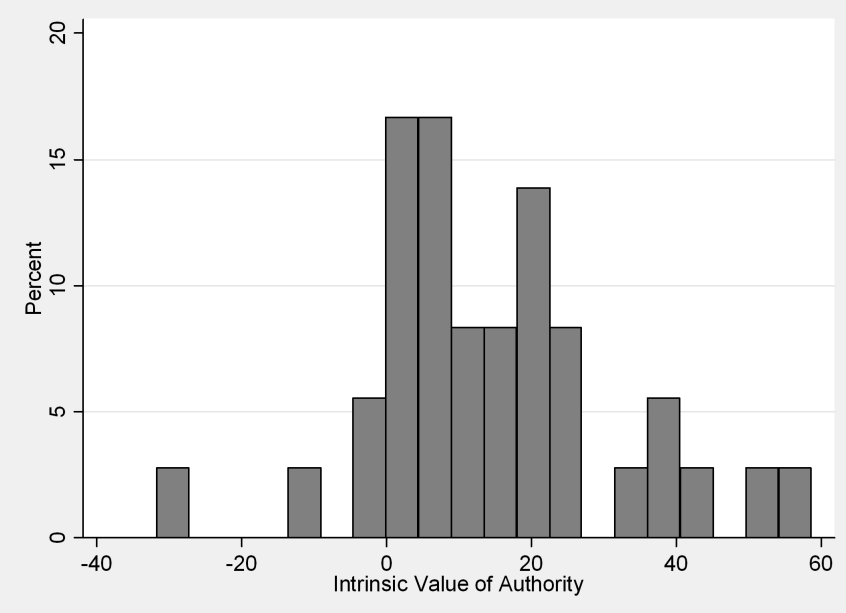



*Figure 2.4:* Histogram of the mean intrinsic value of authority ($MV_{A=1} - MV_{A=0}$), averaged by the individual.

It can be seen that authority is intrinsically valued fairly heterogeneously across individuals. In fact, while the vast majority values authority positively, a small minority of principals prefers to be in the subordinate role. Given that we observe the intrinsic value of authority of every principal in 12 different games, we can test the

robustness of our results at the individual level. If intrinsic value of authority is the consequence of a stable individual preference for authority, within subject variance in the monetary value of authority across our 12 games should be low and we should observe consistency and correlation across the 12 games with regard to who values authority how much. One way to assess the internal validity of our different authority games is to compute Cronbach's alpha, a concept frequently used in psychology and the social sciences as a measure of the internal consistency of a psychometric test score. Cronbach alpha measures to what extent different items in questionnaires, or for our purposes economic games, measure the same latent variable. In order for our experimental method to have internal validity, the results with respect to the measured intrinsic value of authority across the games should be correlated. We could therefore measure the across participant correlation of the average monetary value of authority in the first 6 games and the last 6 games. Since the split in the middle is arbitrary, Cronbach alpha is the mean of all split-half correlations among games. The corresponding formula is $\alpha = \frac{M}{M-1}\left(1 - \frac{\sum_{j=1}^{M} var(x_j)}{var\sum_{j=1}^{M} x_j}\right)$ where $M$ is the number of games, $var(x_j)$ is the variance in the monetary value of authority in the j-th game, and $var\sum_{j=1}^{M} x_j$ is the variance of the sum of the intrinsic value of authority in the M games. Intuitively, $\alpha$ measures the correlation between the games, and varies between zero and unity. If the measured intrinsic value of authority across the games is independent, $\alpha$ is equal to zero, and if it is perfectly correlated Cronbach's alpha is equal to unity. In our data, the Cronbach alpha coefficient of our different measures of the intrinsic value of authority is 0.81. This implies that our different measures of the intrinsic value of authority are positively correlated, and that the intrinsic value of authority affects the delegation trade-off very consistently across the different games.

Given that our games are reliably measuring an intrinsic value of authority that is heterogeneous across participants, it is interesting to study the origins of this preference for authority. What determines the extent to which individuals intrinsically value having authority? In our experiment, we controlled for one important individual preference characteristic, which we considered as a potential correlate of the preference for authority: loss aversion. Empirically, we find that:

**Result 2** *Loss aversion (non significantly) affects the principals' propensity to delegate au-*

*thority. The more loss averse a principal is, the higher she intrinsically values authority.*[26]

Column (1) and (2) of Table 2.4 show regressions of the average monetary value of authority on the principal's loss aversion. For each additional gamble rejected in the lottery treatment, the compensation demanded for the loss of the intrinsic value of authority increases by 2.7 points. Including data from a pilot (column (3)), the coefficient on loss aversion becomes significant.

*Table 2.4:* Monetary Value of Authority

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | MVA | avg. MVA | MVA | MVA | avg. MVA |
| Loss Aversion | 2.743 | 2.743 | 4.811** | 4.890* | 4.811** |
| | (2.422) | (2.446) | (2.246) | (2.589) | (2.116) |
| $P_A$ | | | | –0.277* | |
| | | | | (0.147) | |
| $A_B$ | | | | 0.047 | |
| | | | | (0.070) | |
| $P_B$ | | | | 0.167** | |
| | | | | (0.079) | |
| Constant | 8.248 | 8.248 | 5.634 | 23.117 | 5.634 |
| | (5.766) | (6.460) | (4.616) | (18.156) | (5.549) |
| Adj. $R^2$ | 0.009 | 0.007 | 0.031 | 0.038 | 0.081 |
| Observations | 432 | 36 | 576 | 537 | 48 |

Standard errors are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01

Regressions (1), (3) and (4) use robust standard errors, clustered by the individual.

Regressions (3), (4) and (5) use additional data from a pilot session.

$P_B$ denotes the principal's payoff at variant B.

Regression (4) only includes observations in which variant A was chosen.

Regression (2) and (5) use the average individual MVA as the dependent variable.

Exclusion of principals who were inconsistent in the lottery task does not change any results.

In column (4) of Table 2.4, we also include the payoff parameters of the different authority games into the regression equation. We have seen in figure 2.3 that the measured average intrinsic value of authority varies to some extend across

[26] Including observations from a pilot session, the effect is significant. In this subsection, we also report results when observations from the main sessions and the pilot are pooled. We did not include pilot data in the rest of the analysis, since there were small differences in the procedures between the pilot and the main sessions.

our different authority games. In column (2) of table 2.4, it can be seen that the monetary value of authority marginally decreases in $P_A$, and that it increases in $P_B$. Hence, the more profitable delegation becomes in monetary terms (and the lower $MAE$ should therefore be), the higher is the measured intrinsic value of authority. We saw before that, relative to the benchmark analysis in Section 2.3.1, actual choices of $MAE$ tend to be relatively high when $MAE^*$ is low, and relatively low when $MAE^*$ is high. It is plausible to assume that principals make decision errors in our experiment that create variance in $E$ and $MAE$. We may therefore observe some bias in aggregate data towards the mean when optimal values are close to the boundary of the action space. This implies that our measure might exaggerate the monetary value of authority when $MAE^*$ is low, and underestimate the monetary value of authority when $MAE^*$ is high. This observation could explain why we observe that project payoffs matter in a systematic way with respect to the monetary value of authority. However, an important insight from column (4) is that the game parameters do not eliminate or dampen the effect of loss aversion on the intrinsic value of authority.

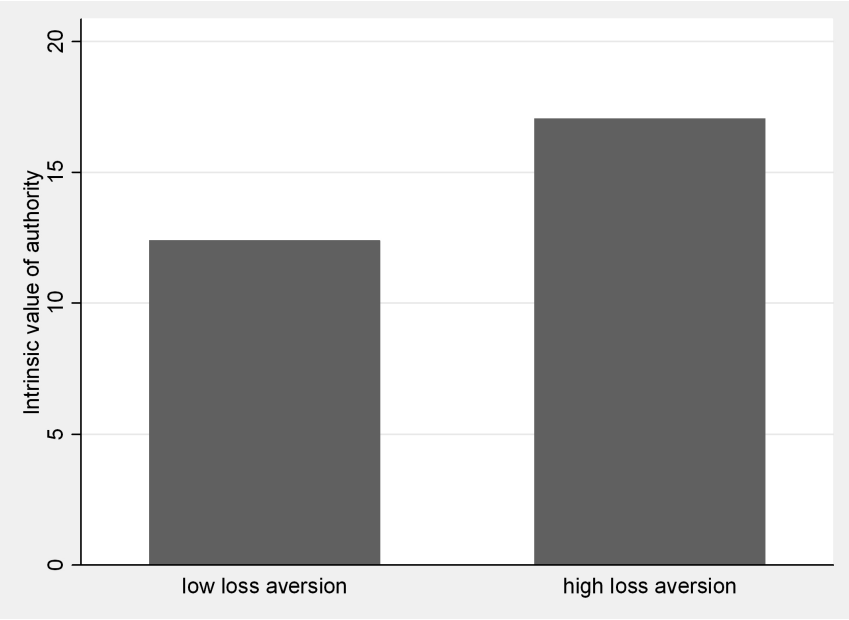



*Figure 2.5:* The monetary value assigned to authority (in points) after splitting the sample in a high and a low loss aversion group (split made at the median).

Figure 2.5 further illustrates the effect of loss aversion on the intrinsic value of authority. If the sample of principals is split in a high and a low loss aversion group (at median loss aversion), it can be seen that the measured monetary value of authority of the high loss aversion group is about 37% higher than that of the low loss aversion group. The effect is, however, statistically not significant using a Mann-Whitney test ($p = 0.27$). Including data from the pilot, the effect becomes significant ($p = 0.04$).

Our conjecture from the correlation between loss aversion and the intrinsic value of authority is that authority may indeed be treated like a good by the principals. People are known to demand more for a good they possess than they are willing to pay for the good they do not possess (Knetsch, 1989; Kahneman, Knetsch, and Thaler, 1990). Theoretically it is well known that there is a positive relationship between an individual's loss aversion in risky choice and the individual's proneness to the endowment effect (Kahneman and Tversky, 1991). This fact seems to be reflected in our data. In our experiment, the difference in certainty equivalents reflects the willingness to accept the loss of authority. The positive correlation between loss aversion and the monetary value of authority therefore suggests that authority is treated similarly to goods. However, more data is needed before conclusive evidence with respect to the correlation between loss aversion and the intrinsic value of authority can be drawn.

## *2.5 Conclusion*

The incentive and efficiency effects of authority have long been recognized in the economics literature. Potential intrinsic effects of authority on utility have been suggested by psychologists, philosophers and political scientists, but have been widely ignored in economics. The experimental revealed preference approach used in this paper controls for preferences over outcomes by experimental design and therefore allows to separate between the intrinsic value of authority and extrinsic utility components relating to pecuniary aspects of authority. This clean distinction provides novel insights for economists as well as the psychology and political science literature. According to our data, principals indeed value authority intrinsically. On average, 14.2% of the overall generated value for an individual with authority can be attributed to intrinsic factors when value is measured in terms of

certain income. The existence of an intrinsic value of authority is further endorsed by the finding that a principal's degree of loss aversion is correlated with the intrinsic value of authority. Moreover, within subject variation in the intrinsic value of authority across different authority games is small, lending further support to the hypothesis that individuals have a stable preference for authority.

Given the importance of authority for the functioning as well as the development and transition of economic and political organizations, we believe that the intrinsic value of authority revealed by our data needs to receive more attention. Organizational design should account for the fact that parties who are directly involved in the decision making process may be biased to keeping authority. Alternative mechanisms which solve the authority assignment problem may be desirable. Intrinsic value of authority is also likely to be a social factor that prevents otherwise favourable mergers, like the examples of Glaxo Wellcome, SmithCline Beecham and others suggest. Our results imply that a better theoretical and empirical understanding of the role of intrinsic value of authority for organizational processes and efficiency is needed. This also directly applies to governance considerations in the political sciences because the reluctance to delegate can cause considerable welfare losses for organizations and, perhaps, even society. Further empirical studies of the determinants and consequences of authority may thus yield important insights. We believe that our empirical approach may prove useful in this respect.

In order to get a better understanding of the intrinsic value of authority, it may also be desirable to disentangle the determinants of the intrinsic value of authority. While the aim of this paper was to establish its existence, an immediate question that arises is what exactly causes authority to be valuable. Several aspects of authority are suggested in the political science and psychology literature as potential determinants of its value, such as conflict of interest, variety of choice and the degree of influence over other parties' outcomes. Our experimental design is suitable to analyze the impact of these factors on the monetary value of authority and we thus hope that our results on the intrinsic value of authority inspire further investigation to shed light on the open questions that remain.

## 2.6 Appendix

### 2.6.A Measuring Loss Aversion

In the main text of the paper, we interpret decisions made in the lottery task presented in section 2.3.4 as being a result of loss aversion rather than risk aversion. This interpretation is based on Rabin's Calibration Theorem (Rabin, 2000) which shows that strictly concave utility of wealth is an implausible explanation for risk averse behavior over modest stakes. In this appendix we apply Rabin's calibration theorem to our lottery game. We show that if individuals have a globally concave utility function over wealth $w \in [0, \infty]$ and rejects gamble three of our lottery game — a coin flip in which the individual can either win CHF 6 or lose CHF 4 — then he or she will reject *any* coin flip in which she could lose CHF 30 no matter how large the positive prize that is associated with the coin flip. This is an implausibly high level of risk aversion while a reference dependent utility function that incorporates loss aversion can easily capture this behavior. We proceed in four steps:

1. We adopt the convention that, if indifferent, the individual rejects the coin flip. Rejecting the coin flip implies

$$0.5u(w+6) + 0.5u(w-4) \leq u(w)$$
$$u(w+6) - u(w) \leq u(w) - u(w-4)$$

   It follows from concavity that $6[u(w+6) - u(w+5)] \leq u(w+6) - u(w)$ and $u(w) - u(w-4) \leq 4[u(w-3) - u(w-4)]$. Define $MU(x) = u(x) - u(x-1)$ as the marginal utility of the xth dollar. Putting the last three inequalities together, it follows that

$$MU(w+6) \leq \frac{2}{3} MU(w-4)$$

   and, by concavity, that $MU(x+10) \leq \frac{2}{3} MU(x)$ for all $x > w-4$.

2. We now derive an upper bound on $u(\infty)$ . The concavity of $u()$ implies

$$u(w+10) \leq u(w) + 10MU(w)$$

Using the same logic,

$$\begin{aligned} u(w+20) &\leq u(w) + 10MU(w) + 10MU(w+10) \\ &\leq u(w) + 10MU(w)[1+\frac{2}{3}] \\ u(w+30) &\leq u(w) + 10MU(w)[1+\frac{2}{3}+\frac{2}{3}^2] \end{aligned}$$

and so on. Thus, we can develop a geometric series starting from $w$. Taking the limit, we obtain

$$u(\infty) \leq u(w) + 30MU(w)$$

3. Concavity implies $u(w-30) \leq u(w) - 30MU(w)$.

4. Using the results from step (ii) and (iii), we get an upper bound on the value of a coin flip where the individual would either lose CHF 30 or win an infinite amount:

$$0.5u(w-30) + 0.5u(\infty) \leq u(w)$$

This implies that the individual would reject the gamble. This concludes the proof.

### *2.6.B Illustrating the Measure for the Value of Authority*

This appendix illustrates one possibility how to model the intrinsic value of authority. We assume that the value of authority, $MV_{A=1} - MV_{A=0}$, enters utility in an additively separable way. For ease of presentation, the agent's payoff is ignored in this analysis.

In this case, authority causes an upward shift of the utility function. There are two potential outcomes, $x_1$ and $x_2$. The probabilities are weighted such that the expected value of this lottery is given by $EV(x)$. The utility derived from this lottery depends on the allocation of authority and is depicted on the vertical axis. If the individual has authority, his utility is $u(x_1, x_2|A = 1)$ , and if the lottery is evaluated in an authority neutral framework, the utility is $u(x_1, x_2|A = \oslash)$. The

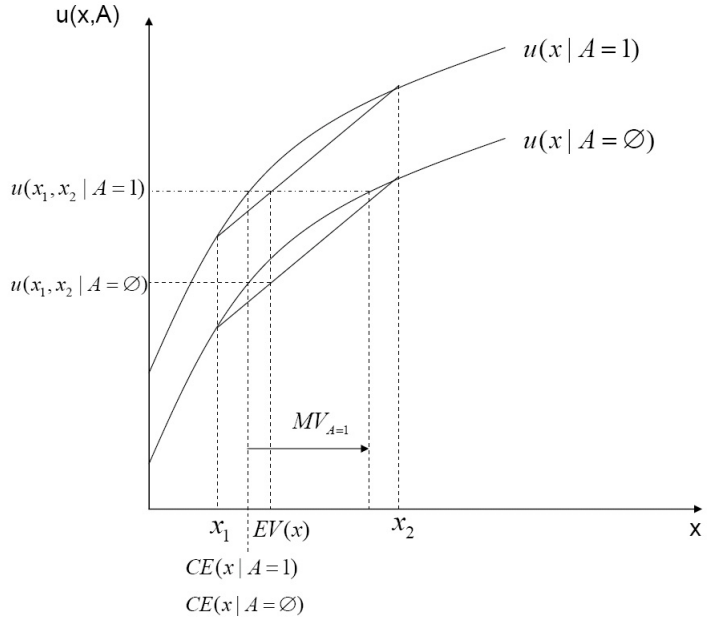



*Figure 2.6:* Example of the effect of authority on utility (1)

certainty equivalent is independent of authority in this case (since authority is assumed to have no effect on the risk attitude). The monetary value of authority relative to the authority-neutral framework can be seen in the picture ($MV_{A=1}$). It is the amount of money which needs to be added to the certainty equivalent in the authority-neutral framework, such that the utility is as high as if the individual had authority.

The same analysis can be done when comparing the utility derived from a lottery when being the subordinate to the same lottery in the authority-neutral framework. Here, by assumption, the utility when not having authority is lower than in the authority neutral framework. Again, the risk attitude remains unchanged. The monetary value of not having authority relative to the authority-neutral framework ($MV_{A=0}$) is depicted in figure 2.7. It is a negative number, since utility is higher in the authority neutral framework.

Putting both pictures together, we can see how our measure of the value of authority is constructed. Having authority and not having authority leads to different levels of utility. We evaluate this difference in utility in terms of certain payoff con-

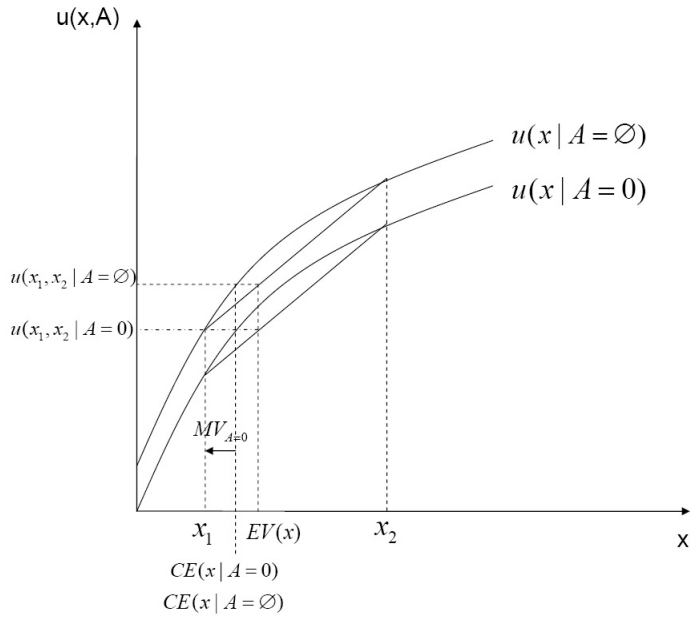



*Figure 2.7:* Example of the effect of authority on utility (2)

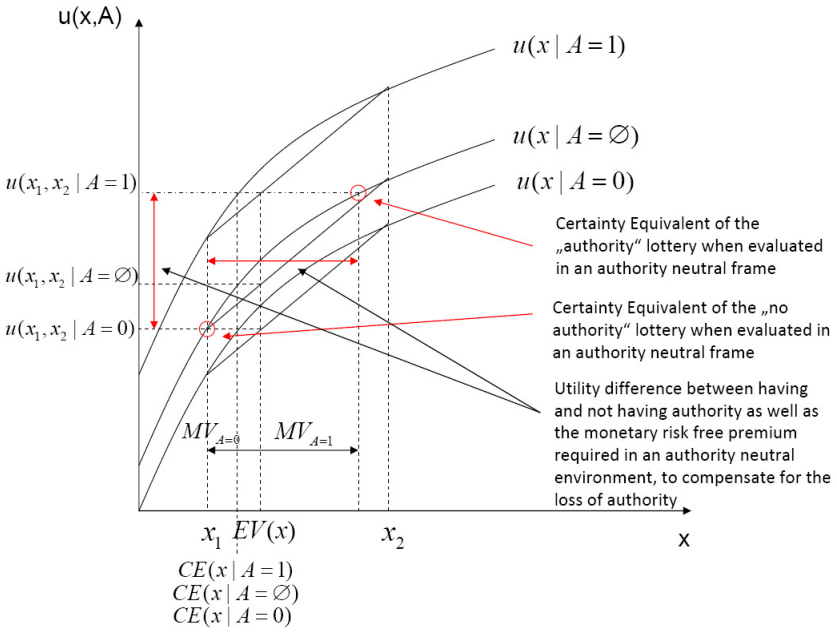



*Figure 2.8:* Example of the effect of authority on utility (3)

ditional on authority-neutrality.

### *2.6.C Using Expected Values instead of Certainty Equivalents*

Can our results be replicated using expected values instead of certainty equivalents? If this is the case, the complicated procedure of eliciting the certainty equivalents may be obsolete and it would ease the experimental procedure of eliciting preferences for authority.

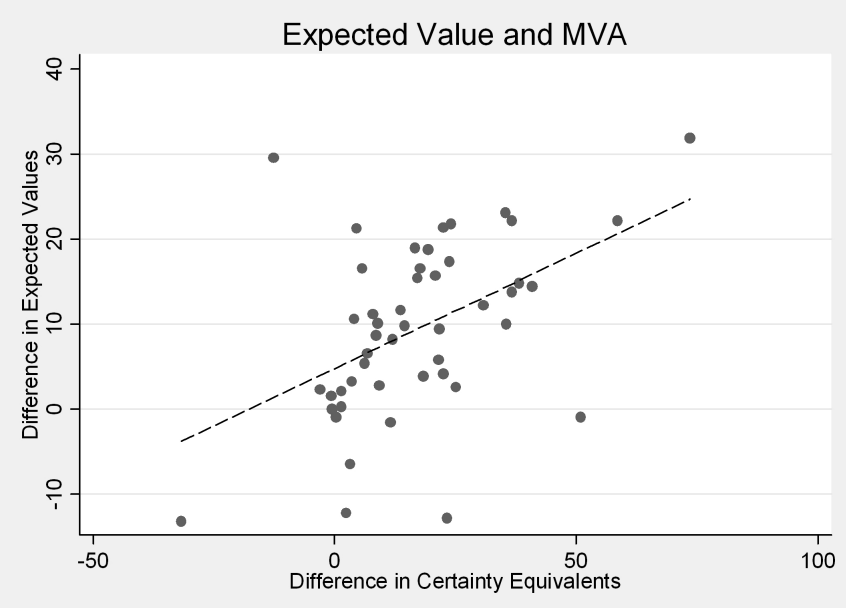



*Figure 2.9:* Pairwise plot of the differences in expected values plotted against the differences in certainty equivalents, averaged at the individual level

Figure 2.9 shows pairwise plots of the averaged difference in expected value and the averaged difference in certainty equivalents of the authority lottery and the subordinate lottery for each principal in our experiment. There is a clear positive correlation between the two measures, and the correlation coefficient is $\rho = 0.48$, which is significant at the 0.01 percent level. Given that the expected value criterion neglects the impact of risk as well as social preferences, we consider the correlation as being fairly high.

It therefore seems that the difference in expected values may already be a good indicator of the value assigned to authority. Whether this implies that expected

values can be used instead of certainty equivalents as proximate measures of the intrinsic value of authority will however depend on the replicability of our main results using this alternative measure.

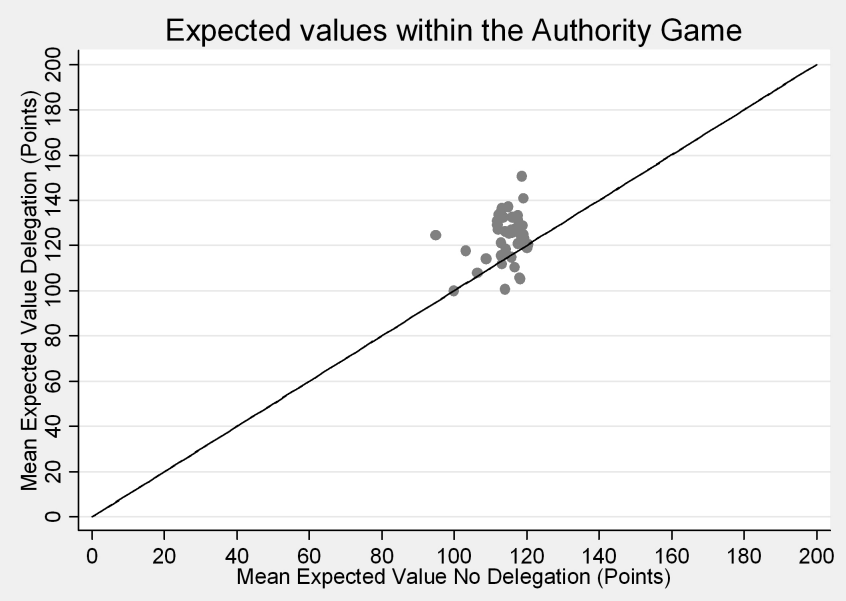



*Figure 2.10:* Pairwise plots of the mean expected value of the lottery resulting from minimal agent effort and the lottery resulting from own effort, averaged at the individual level

Figure 2.10 shows pairwise plots of the mean expected value of the lottery resulting from minimal agent effort and the lottery resulting from own effort, averaged at the individual level. A Wilcoxon signed rank test rejects the null hypothesis that these averages are equal at the 1 percent level (p=0.00).

Figure 2.11 shows that the difference in expected values is a robust predictor of the monetary value of authority across the different games. Just as the difference in certainty equivalents, the difference in expected values is significantly larger than zero in 10 out of 12 games. However, the magnitude of the difference is smaller when neglecting the impact of risk and social preferences. Correlations of the two measures, difference in certainty equivalents and difference in expected values, range from 0.1 to 0.62 across the 12 games, with an average, as stated above, of 0.48. Except for two games (1 and 4), pairwise correlations in each game are significant at the 1% level.

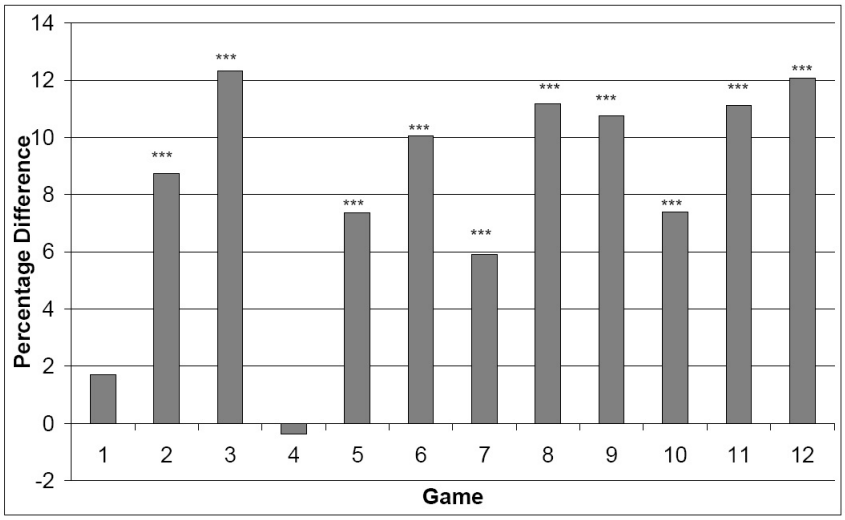



*Figure 2.11:* Average percentage difference between the expected value of the subordinate lottery and the expected value of the control lottery, sorted by authority game. Significance levels calculated using Wilcoxon Signed-Rank tests: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.


*Figure 2.12:* The difference in expected value of the lotteries after splitting the sample in a high and a low loss aversion group (split made a the median).

Figure 2.12 shows that loss aversion has no significant impact on the difference in expected values. Hence, result 2 fails to be replicated using the simpler measure of expected values instead of certainty equivalents when evaluation the lotteries which result from the effort and minimal agent effort choices.

We can therefore conclude that the monetary value of authority is strongly correlated with the difference in expected values associated with the lotteries resulting from kept vs. delegated authority, and using expected values of lotteries instead of certainty equivalents replicates result 2. The expected value of the principal's payoff when delegating authority is on average 9.3 points or 7.5% higher compared to the expected value when choosing his own effort. However, loss aversion is not significantly correlated with the difference in expected values of the authority and the delegation lottery. More experiments are necessary to shed light on this discrepancy.

### *2.6.D Discussion of alternative designs*

This paper introduced a method to measure the value of authority by eliciting a monetary value at which a principal is willing to accept the loss of authority. However, there is evidence that the willingness to accept can differ from the willingness to pay for goods, due to endowment effects (Knetsch, 1989; Kahneman, Knetsch, and Thaler, 1990). Hence, it might be desirable to design an experiment which measures the willingness to pay for authority instead of the willingness to accept.

Moreover, the current design is complex and time consuming. The elicitation of the value of authority is done in an indirect way, nowhere in the experiment do the subjects explicitly state how much they value having authority. Therefore, the question arises whether it is possible to elicit the value of authority directly. A simpler design which achieves the goal to measure the value of authority, independent of the risk and monetary aspects of the decision environment, would be very desirable.

In this chapter, 4 alternative design proposals are presented, which aim to achieve this goal. The proposals will be critically evaluated and the problems involved with each approach will be highlighted.

*Willingness to Pay for Authority*

*Design*

The first alternative is closely related to the design presented in chapter 2. Instead of measuring the willingness to accept the loss of authority on the principal's side, this approach focuses on the agent and his willingness to pay to receive authority. The setup of the experiment is similar to the design presented in chapter III, but the actions taken by the principal and the agent are different. The design is based on 5 stages. In stage 1, the principal chooses his effort level in case he keeps authority (via strategy method). In stage 2, the agent is informed about the distribution of effort choices of the principals, and he then announces his willingness to pay for the decision right. In stage 3, the agent announces his effort choice in case he gets the decision right (again via strategy method). Then, a random mechanism determines a price for the decision right, and the decision right is given to the agent in case his willingness to pay for the right is larger than the requested price. This mechanism guarantees incentive compatibility, such that the agent reveals his willingness to pay for authority in the given situation. In stage 4, the agent is confronted with a series of lotteries. One half of the lotteries result from his own effort choices in case he gets authority, his payments for authority and the values of the corresponding project associated with success and failure. The compound lotteries resulting from the effort choices of the principals and the associated payoffs in case of success and failure, when the principal keeps the decision right, make up the other half. These lotteries are presented in an authority-neutral framework. Certainty equivalents of these lotteries are elicited, as it has been described before.

*Discussion*

As in the original design (presented in chapter 2.3), the value of authority is measured via the difference in certainty equivalents associated with the lotteries which result from the effort choices and the willingness to pay for authority. The agent should choose his transfer $T$ such that his utility in case he gets authority is never smaller then in case the principal keeps authority. By revealed preference,

the following condition has to hold[27]

$$U(x, y, E|A = 0) = U(x', y' - T, e|A = 1) \tag{2.21}$$

$e$ is the agent's effort choice if he acquires the decision right, $E$ is a vector containing the distribution over effort levels chosen by the principals. $T$ denotes the payment for authority, $x$ and $x'$ the payoffs (resp- distribution of payoffs) for the principal, $y$ and $y'$ the payoffs for the agent. The authority-neutral certainty equivalents can again be compared in order to find a measure for the willingness to pay for authority.

$$CE(x', y' - T, e|A = \oslash) + MV_{A=1} = CE(x, y, E|A = \oslash) + MV_{A=0} \tag{2.22}$$

$$MV_{A=1} - MV_{A=0} = CE(x, y, E|A = \oslash) - CE(x', y' - T, e|A = \oslash) \tag{2.23}$$

The discussion above reveals several problems. In a design which incorporates a payment for authority, this payment cannot be used as a direct measure of the value of authority. The decision environment in the two potential authority roles is fundamentally different, and the distribution of authority is not the only difference. The payoffs to both parties, the probabilities and the amount of ambiguity is different, which of course causes differences in received utility between having and not having authority, which have nothing to do with authority by itself. It is therefore again necessary to control for these differences, by eliciting certainty equivalents. This additional step is therefore not an artifact of the willingness to accept design used in this paper. The payment to the principal is just another tool to achieve directly comparable lotteries, just as the minimal effort requirement did in the original design.

Moreover, the willingness to pay design fails to make the experiment faster. And instead of making the experiment simpler, it in fact becomes even more complicated. The lotteries that result in case the other party has the decision right is no longer a simple lottery, but a compound lottery. This implies that the representation in an authority free context is much more complicated. Especially, since not

[27] Note that $E$ is a distribution over different effort levels and $x$ denotes the associated distribution over payoffs for the principal.

only the success probabilities are stochastic, but also the payment to the principal, $y'$, since $y'$ is a function of the principal's effort.

As an alternative, the agent could be informed about the effort of the principal he is directly matched with. This would avoid complications arising in the certainty equivalent elicitation stage. However, such a design would take away an important notion of not having control, i.e. that the process by which payoffs are determined is in someone else's hand. If this choice by someone else is already made, the agent essentially confirms this choice by not getting authority, thereby keeping control over the process which determines final outcomes. He keeps the last word no matter which authority structure is finally implemented. We think that this is an undesirable feature if one wishes to measure the value of authority. The agent essentially has authority independent of the distribution of the decision right, and positive valuations associated with exercising authority may be present in both situations, delegation and kept control.

*Simple Willingness to Pay Experiment*

The main concern with the current design is its complexity. It would be worthwhile to have a simpler experiment which also captures the preference for authority. However, simple designs suffer from the fact that they may render authority meaningless. Having authority and power implies a certain freedom and room to have influence on outcomes. However, as soon as one party has influence, it is complicated to evaluate the value of making own decisions. The proposal here describes a situation in which there is room to make own decisions, but effectively the decision is meaningless. Hence, authority should not be valuable for subjects if they only consider authority as an instrument.

*Design*

There is a set of 10 projects to choose from. 8 projects are worth a small amount, and 2 projects are worth larger amounts. All projects pay the same amount to the agent and the principal. However, ex ante all projects look identical and the subjects cannot distinguish between them. In this experiment, no information can be acquired about the projects. The only choice that can be made is to pick one of the projects. The party with authority gets to make this choice. There are two

procedures to assign authority to one of the subjects: An auction mechanism or a price mechanism. Both mechanisms are incentive compatible and elicit a subject's willingness to pay to make the project choice decision. In a price mechanism, each subject states his maximal willingness to pay for the decision right. A random price for the right is then determined, and if the price is below the maximal willingness to pay, the decision right is given to the subject for the randomly chosen price. If the price is above the willingness to pay, the right is given to the other party and no payments are made. In an auction mechanism, both parties state their maximal willingness to pay for the decision right, and the party with the higher bid gets the right for the price of the lower bid.

*Discussion*

Theoretically, the willingness to pay for authority in this experiment should be zero. Since nothing is known about the projects, each project is essentially identical ex ante. It has the same expected payoff and the same probability distribution over payoffs. Hence, independent of a subject's risk attitudes, it does not matter whether he himself chooses a project or whether the other party chooses the project. If a subject however reveals a willingness to pay for authority, it must have to do with wanting the right to take the decision and to be self determined. Given that uncertainty is independent of having authority, there is no need to control for preferences over uncertain outcomes. This makes the second stage of the experiment (the lottery experiment) unnecessary. The experiment asks for the willingness to pay for authority and therefore gives a direct measure. There is no need to calculate the value of authority indirectly from other observables. Hence, the experiment is fairly simple and it delivers a direct measure, a revealed willingness to pay for authority. However, as mentioned above, it might suffer from the shortcoming, that authority is meaningless in such an environment. The problem is closely related to the Illusion of Control (Langer, 1975). However, in our setting there are two human parties involved, which potentially makes it different since it implies an authority structure. An illusion of control treatment would be an additional control treatment.

*Choice between two allocations*[28]

Simple choice experiments of payoff allocations may also be potentially interesting to study the value of making own decisions. It also seems to be an appealing and simple method to measure the value of authority. However, these designs also suffer from shortcomings and as it turns out, they are not substantially simpler than the design presented in this chapter.

*Design*

Andrei Shleifer proposed the following design: A subject can choose between two allocations $(30/30)$ $(0/0)$ or he lets another subject choose between alternative allocations $(x/x)$ $(0/0)$. The subject then has to decide how high $x$ need to be for him to be willing to give the decision right to the other subject.

*Discussion*

The difference between $x$ and 30 $(x - 30)$ may be interpreted as a willingness to pay to keep the decision right. However this does not reflect the pure willingness to pay for authority, because the measure is confounded with risk and ambiguity aspects. Given that someone else makes a choice between two allocations, there might be a belief that the other subject makes a mistake, which creates risk. Hence, requiring a premium to give up the decision right might be rational, independent of the value of authority. This implies that even in this design an explicit elicitation of valuation of the two situations is necessary to pin down the pure value assigned to authority. In this regard, the potentially simple game turns out to be just as complicated (or only negligibly less complicated) than the original design. Most importantly, the difference between $x$ and 30 alone cannot easily be interpreted as a willingness to pay for the decision right.

[28] Experiments in this fashion have been proposed by Andrei Shleifer.

*Choosing a single allocation*[29]

*Design*

Another design which goes in a similar direction has been proposed by Matthew Rabin. Either a subject himself chooses the distribution $(10/10)$ or he lets someone else choose $(x/x)$. How large needs $x$ to be to be willing to delegate the right to make the decision?

*Discussion*

$x - 10$ would in fact be an easy measure for authority, since there is no risk involved (there is only one action in each actors action space). However, the decision right is essentially meaningless. On a more global level, by delegating the decision right I myself implement the allocation $(x/x)$ with certainty. Hence, delegation implies no loss of control over final allocations or the process by which the final allocation is reached. This implies that it is very unlikely to find a value of authority in such a design. Making authority meaningful (in the sense that it enables the controlling party to choose an action out of a non singleton set of actions) seems an important property of authority.

[29] This design has been proposed by Matthew Rabin.

# 3. JUDGEMENTAL OVERCONFIDENCE AND INNOVATIVE ACTIVITY - EVIDENCE FROM THE LAB AND FROM THE FIELD

*Chapter Overview*

Innovation is essential for growth and success of organizations. This paper formalizes the creative process that underlies innovative activity. Based on our model we hypothesize that judgemental overconfidence can be detrimental to innovative activity and test this prediction using experimental methods. The hypothesis is confirmed by the data. Moreover, we test the external validity of experimental methods with regard to innovative activity at the workplace. By matching experimental data of managers in a financial industries company with external supervisor ratings of innovative activity at the workplace, we find that performance in the experiment correlates strongly with observed innovativeness in the company.

## *3.1 Introduction*

Innovation is an important driving force of economic growth. Without new products, innovative technologies and entrepreneurial spirit, it is difficult to sustain economic growth and to improve welfare (Schumpeter, 1943; Aghion and Howitt, 1997). It is therefore important for the economy and companies to generate and sustain an innovative spirit and atmosphere among their workforce. This fact is well known among business leaders, who mention innovation among the top priorities for their companies and innovativeness among the most important characteristics of employees.[1]

Given the importance of innovation for businesses and the economy in general, it is not surprising that academic research has become increasingly interested in innovative activity and creativity. Innovation is often defined as a two stage process that involves the creation and the implementation of novel ideas (Amabile, 1996; Rank, Pace, and Frese, 2004). Questionnaires measuring aspects of innovative activity, such as self-initiative (Frese, Kring, Soose, and Zempel, 1996), pro-activity (Bateman and Crant, 1993) and taking charge behavior (Morrison and Phelps, 1999) have been developed and some researchers have started to study the antecedents and determinants of innovative behavior at the workplace, such as leadership, individual problem-solving style and work group relations (Scott and Bruce, 1994; West, 2002). However, theoretically and empirically, the process underlying innovative activity is still fairly poorly understood.

This paper deepens the theoretical and empirical understanding of the individual determinants of innovative activity. We build a model of innovative activity that primarily focusses on the creative process of idea generation.[2] In our model, creative outcomes, for example novel products, technologies or business strategies, depend on individual ability, but also have a random component. This modeling strategy aims to capture the intuition that innovative outcomes are the result of a long lasting creative and creative process within which many ideas are generated, dismissed or improved upon. The existence of variance in the idea generation pro-

[1] CEO Challenge 2004: Perspectives and Analysis, The Conference Board, Report 1353 and Mc Kinsey Global Survey 2007.

[2] We recognize that implementation is equally important, and that implementation may require very different skills relative to the creative aspect of innovation.

cess is precisely what makes the generation of multiple ideas optimal because this is the only way to learn about the relative goodness of existing ideas.[3] To capture this aspect of the creative process, we model idea generation as a stochastic process where ideas are drawn from a distribution that depends on underlying profitability of the problem as well as individual ability. Importantly, we assume that the degree of randomness that is involved in the idea generation process is itself an individual ability parameter. This reflects the intuition that some people are more and some are less precise in drawing conclusions from accumulated information with regard to the problem at hand.

The model allows us to derive predictions with regard to behavioral biases that may inhibit individual innovative activity. We focus in particular on judgemental overconfidence, the tendency to overestimate the precision of one's information. We measure this bias using a confidence-interval task (Russo and Schoemaker, 1992), which has previously been used to analyze the effects of judgemental overconfidence on trading performance in experimental financial markets by Biais, Hilton, Mazurier, and Pouget (2005). Under the assumption that the creative phase of the innovative process is a stochastic process with variance in the quality of generated ideas, it is optimal to generate multiple ideas before moving towards the implementation phase, and that number will depend on the variance of the process. Miscalibrated subjects, however, will underestimate this variance, and our model predicts that this behavior biases the number of generated ideas downwards and can lead to the implementation of suboptimal ideas, which hurts the profitability of the innovation.

In order to test our theoretical predictions, a behavioral measure of individual innovative activity is needed. In previous experimental work on the effects of incentive systems on innovative activity, Ederer and Manso (2010) used a management game, the so-called lemonade stand task, that focusses on an exploration-exploitation trade-off as a potential behavioral measure of innovative activity. In their game, subjects have to solve a management task in which innovating the product mix is central. They define innovation as the production of knowledge through experimentation (Arrow, 1969; Weitzman, 1979) and the central concern

[3] For example, Linus Pauling once said that the best way to have a good idea is to have many ideas.

that arises when learning through experimentation is the tension between the exploration of new untested approaches and the exploitation of well known approaches (March, 1991). Hence, they use explorativeness measures within the experiment as proxies for innovative activity. We extend Ederer and Manso's game to test our hypothesis. In our experiment, subjects run an ice cream stand for 20 periods, and they are given the possibility to innovate and explore the product mix in several dimensions. In order to increase profits substantially, radical changes in the product mix are necessary. Subjects work under an exploration contract, which implies that they are only paid according to their performance in the last 10 rounds of the experiment. Ederer and Manso (2010) have empirically shown that such a contract is effective in motivating innovation. We extend the original task in one important dimension: We add flavour as a strategic variable. Flavour differed from the other variables since the subjects were not given predefined flavours to choose from. Subjects were completely free to choose a flavour of their liking. In contrast to the other strategic variables, subjects therefore not only had to explore the available options, but they had to explore the action space based on their own ideas with regard to potentially profitable flavours. We deliberately left the action space ambiguous in order to extend the innovative and creative ability needed to be successful in the experiment beyond pure exploration. The task allows us to define several behavioral measures of innovative activity and to use these measures in order to test our theoretical predictions.

We find that judgemental overconfidence leads to a significant reduction in innovative activity. The exploratory phase, the number of periods in which a subject radically alters the product mix and explores alternative business strategies before turning towards fine-tuning and exploiting a particular strategy, is significantly reduced in the degree of judgemental overconfidence. Subjects with above median overconfidence on average engage in exploration for approximately 1.65 periods less than subjects with judgemental overconfidence below the median. Moreover, the average subject specific standard deviation in strategy choices is significantly lower the higher the degree of judgmental overconfidence and the number of explored flavours also significantly decreases in the degree of judgemental overconfidence. The behavioral measures of innovative and explorative activity in the experimental task therefore confirm our theoretical hypothesis: Judgemental overconfidence reduces the investment into innovative activity.

Our model not only predicts that judgemental overconfidence is detrimental to innovative activity, but that the reduction in innovative activity has real consequences on profits due to the implementation of suboptimal business strategies. Our results support this prediction. Using robust regression methods, profits in the ice cream task are significantly reduced in the degree of judgemental overconfidence. When considering the maximum per period profit, which measures the peak performance during the experiment instead of the overall performance, the same picture emerges. The maximum per period profit is also significantly smaller the larger the degree of judgemental overconfidence. Our experimental data therefore suggests that judgemental overconfidence has strong implications for individual innovative activity and has to be taken seriously as a determinant of innovation.

The paper contributes to a growing literature on the behavioral determinants of innovation. For example, Galasso and Simcoe (2010) analyze the effect of CEO overconfidence in ability on innovation and show that this form of overconfidence increases innovative activity, measured by citation-weighted patent counts of the CEO's company. It is important to note that overconfidence in ability, or having a positive illusion of future success rates, is different from judgemental overconfidence as we consider it in this paper. This has been shown by Hilton, Regner, Cabantous, Charalambides, and Vautier (forthcoming), who find no correlation between miscalibration and overconfidence in ability. Different forms of overconfidence therefore have opposing effects on innovative activity. While overconfidence in ability fosters innovation, overconfidence in precision reduces innovative activity.

Our finding suggests that there is strong heterogeneity in individual innovative ability and that these differences can be linked to personality characteristics. The fact that judgemental overconfidence is detrimental to innovative activity points towards an important determinant of innovative activity and confirms the general wisdom among creativity researchers that perseverance in the idea generation process is necessary to come up with true innovations. This insight complements a growing literature that outlines the importance of overconfidence in judgement in a variety of domains. It is known that overconfidence in precision matters because humans overestimate the precision of signals in financial markets (Biais, Hilton, Mazurier, and Pouget (2005)), because they underestimate variance in cell phone

usage which makes them suspect to exploitation by contractors (Grubb (2009)) and that humans underestimate the degree to which their future tastes will differ from their current tastes, which leads to underestimation of future demand (Conlin, O'Donoghue, and Vogelsang (2007)).

One caveat of the experimental approach to studying individual innovative activity is the limited evidence on its generalizability. It is not clear that the behavior in the experimental game under consideration indeed reflects innovative activity as it is crucial for companies. Exploration, the selection of previously untested strategies, reflects one potential aspect of the creative and innovative underpinnings of the idea generation process. But so far it has not been tested whether the experimental exploration-exploitation trade-off that is inherent in the experimental management game is indeed related to innovative activity at the workplace. The strength of experimental methods is that they provide a behavioral measure of individual innovative activity. From a scientific viewpoint, such a behavioral measure is highly desirable because it allows studying the determinants of innovative activity under controlled conditions and it enables the researcher to analyze ceteris paribus effects of policy changes on innovative activity. Establishing an experimental behavioral measure, as we use it in this paper and as Ederer and Manso (2010) have previously used it in related research, would therefore significantly advance the scientific toolbox for the analysis of innovation.

In order to test the external validity of our behavioral measure of innovative activity, we collected experimental data from middle-managers of a financial services company. In addition to the experimental data, we collected external data of creativity, gestalt motivation, action orientation, taking charge behavior and performance at the workplace by surveying the supervisors of the managers in the company. Our external measures are therefore a direct assessment of the employee's behavior at the workplace.

We find that performance in the experimental task is strongly and highly significantly correlated with the external measures of creativity, performance, gestalt motivation and taking charge behavior. This finding implies that the laboratory setting is well suited to study the determinants and antecedents of innovative behavior.

The study of the individual determinants of initiative, creativity and innovation at the workplace has so far been limited to questionnaire methods (see Bateman

and Crant (1993), Morrison and Phelps (1999) and Parker (1998)), and interviewing techniques (see Frese, Kring, Soose, and Zempel (1996)). While these methods deliver interesting insights and correlational evidence with respect to determinants of innovative activity, they also have obvious limitations. Most of them are self-report questionnaires, and they rely on truthful reporting of the employee. Strategic considerations on the employee's side may render the insights from these questionnaires questionable. Moreover, eliciting personality characteristics through questionnaire or interviewing methods does not give the researcher a behavioral measure of innovative activity, and therefore they do not permit the study of policies or the impact of institutions on innovative activity in a ceteris paribus fashion. Finally, it is also of practical relevance, because it can be used in the ex-ante screening of employees with respect to their innovative characteristics.

The paper proceeds as follows: In Section 3.2, we present a theoretical framework and derive predictions with regard to creativity and innovative activity. In section 3.3, we introduce the experimental design, the experimental procedures and the subject pool as well as the measurement of judgemental overconfidence and controls in detail. In Section 3.4, we relate our theoretical model to the experimental task and derive hypotheses with regard to our behavioral measures of innovative activity and judgemental overconfidence. Section 3.5 presents the results and Section 3.6 relates our experimental measures to external measures of innovative activity at the workplace. Finally, Section 3.7 concludes.

## *3.2 Theoretical Framework*

We develop a theoretical framework to explain the creative process that is underlying innovative activity. Innovation is often defined as a two step process that is divided into a creative phase in which ideas are generated and an implementation phase in which the best available idea is implemented (see Amabile (1996) and Rank, Pace, and Frese (2004)). The creative phase and the implementation phase are both important components of the innovative process and they may require very different skills. Our focus will be on creativity, the first phase of the innovative process. A novel idea which addresses the problem is needed for a successful innovation, independent of whether one thinks about large technological innovations or small innovations in organizational processes. The ability to generate novel,

valuable ideas is therefore a fundamental characteristic of the innovative process. In this model, we focus on this creative component of the innovative process and model innovative activity as an idea generation process.[4]

In our model, an agent can generate ideas for a novel project. Ideas are fully described by their monetary present value to the agent and are denoted by $\omega$. The agent can generate as many ideas as he wishes. However, generating ideas is costly. The cost of generating an additional idea is $c$. Instead of generating a new idea, the agent also has the option to implement the most profitable idea available in the set of previously generated ideas. Hence, every time the agent wants to generate another idea, he faces a trade-off between the cost and the benefits of an additional idea.

The project itself is characterized by a minimal payoff potential, which determines the lower bound of the potential value of an idea. We assume that the minimal payoff potential cannot be directly observed by the agent, based on the assumption that innovation takes place in areas where there is ambiguity with regard to payoff potential. The project is therefore characterized by an unobservable minimal payoff potential $\underline{\omega}$, which reflects payoffs from the project that can be realized without requiring additional creative input by the agent and which are therefore independent of the agent's innovative abilities. In order to incorporate the importance of individual ability in the innovative process, we define an individual ability parameter $\theta_i$ that determines how much value the agent can maximally add to the project. Therefore, the maximum present value of an idea that an agent $i$ can achieve is $\underline{\omega} + \theta_i$. We assume that there is a random component to creativity and that there is heterogeneity in this randomness across agents. We model this aspect by assuming that an idea is a draw from a distribution that depends on the precision of the idea generation process of the agent. Every agent has a precision parameter $\gamma_i$, which determines the variance of an agent's idea generation process. Every time an agent generates an idea, this is modeled as a draw from a uniform distribution with lower bound $\underline{\omega} + \theta_i - \gamma_i$ and upper bound $\underline{\omega} + \theta_i$. Hence, $\gamma_i$ determines the size of the interval from which ideas are drawn. Note that $\gamma_i$ also affects the mean of the distribution from which ideas are drawn. Figure 3.1 illustrates the distribution underlying the idea generation process.

[4] The patent lottery literature in law uses a related approach (see Crouch (2008)).

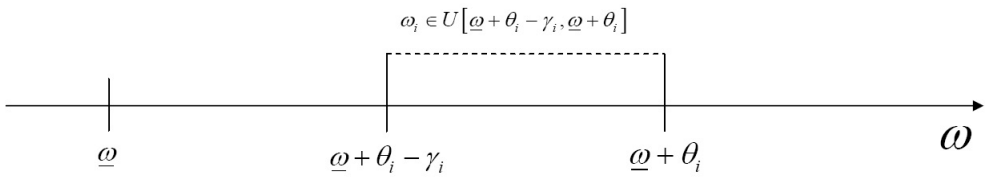



*Figure 3.1:* Illustration of the distribution from which an individual $i$ draws ideas, given $\underline{\omega}$, $\theta_i$ and $\gamma_i$.

Modeling the idea generation process this way captures several aspects of the innovative process. First of all, the bounds of the distribution from which ideas are drawn are unknown. This is due to the lack of information about $\underline{\omega}$. Second, individuals can differ with regard to their ability to add value to a project. This is captured by $\theta_i$, which is an ability parameter. $\theta_i$ captures the maximal value that an individual can add to a project due to his individual abilities. Third, there is randomness in the idea generation process. This randomness can differ across individuals. $\gamma_i$ captures the randomness of the idea generation process of individual $i$. We require that $\theta_i \geq \gamma_i$.

### *3.2.1 Solving the Model*

Every agent can repeatedly decide whether he wants to generate an additional idea. The agent faces the trade-off between increasing the present value of the project by discovering a better idea than previously available, and paying the cost of creating an additional idea, $c$. We can denote the best available idea after $n-1$ ideas have been generated by

$$\omega_{n-1:n-1} = \max[\omega_1, \omega_2, ..., \omega_{n-1}] \tag{3.1}$$

When drawing one additional idea, the net present value of the best available idea will be

$$\omega_{n:n} = \max[\omega_1, \omega_2, ..., \omega_{n-1}, \omega_n] \tag{3.2}$$

The agent should generate an additional idea if

$$E\left[\omega_{n:n}|\omega_1, \omega_2, ..., \omega_{n-1}\right] - \omega_{n-1:n-1} \geq c \tag{3.3}$$

In every period, the agent hence faces the trade-off between the expected increase in present value of the best available idea when generating another idea, and the cost of idea generation. Given this consideration, we can now solve for the expected number of periods, in which an agent generates an idea, and how it depends on $\gamma_i$ and $\theta_i$.

The expected value of $\omega_{n:n}$, given our distributional assumptions, follows directly from the n:n-th order statistic and is given by

$$E(\omega_{n:n}) = \underline{\omega} + \theta_i - \frac{\gamma_i}{n+1} \tag{3.4}$$

The expected increase in net present value when drawing an additional idea in period $n$ is given by

$$E[\omega_{n:n}] - E[\omega_{n-1:n-1}] = \underline{\omega} + \theta_i - \frac{\gamma_i}{n+1} - \left[\underline{\omega} + \theta_i - \frac{\gamma_i}{n}\right] \tag{3.5}$$

$$E[\omega_{n:n}] - E[\omega_{n-1:n-1}] = \frac{\gamma_i}{n} - \frac{\gamma_i}{n+1} \tag{3.6}$$

$$E[\omega_{n:n}] - E[\omega_{n-1:n-1}] = \frac{\gamma_i}{n(n+1)} \tag{3.7}$$

The expected number of periods $n$ in which a subject should therefore on average engage in the idea generation process is therefore determined by

$$E[\omega_{n+1:n+1}] - E[\omega_{n:n}] \geq c \tag{3.8}$$

$$\frac{\gamma_i}{n(n+1)} \geq c \tag{3.9}$$

Solving this equation for $n$ gives:

$$n \leq \sqrt{\frac{1}{4} + \frac{\gamma_i}{c}} - \frac{1}{2} \tag{3.10}$$

The following conclusions can be drawn from this solution. First note that $n$ is independent of $\underline{\omega}$ and $\theta_i$. These two parameters only determine the support of the distribution. The size of the interval is solely determined by $\gamma_i$. The difference be-

tween the $n:n$-th and the $(n-1):(n-1)$-th order statistic however only depends on the length of the interval. Therefore, $\gamma_i$ is the only individual variable in our model which explains the length of the idea generation process. $n$ is increasing in $\gamma_i$. The higher the variance in the idea generation process, the larger the expected number of periods is, in which an agent optimally engages in the creative task. $n$ is decreasing in $c$. This is straightforward, since $c$ determines the cost of engaging in the creative task. The larger this cost, the earlier it is optimal to stop searching for better ideas and to implement the best idea available.

Given the optimal solution for $n$, we can also solve for the expected profit of the agent:

$$E(\omega_{n:n}) = \underline{\omega} + \theta_i - \frac{\gamma_i}{n+1} \tag{3.11}$$

$$E(\omega_{n:n}) = \underline{\omega} + \theta_i - \frac{\gamma_i}{\sqrt{\frac{1}{4} + \frac{\gamma_i}{c}} + \frac{1}{2}} \tag{3.12}$$

A few observations can be made with regard to expected profit. Expected profit is increasing in $\underline{\omega}$ and $\theta_i$. These variables determine the upper bound of the idea distribution. The larger these variables, the higher the net present value of ideas is, and therefore the realized profit of the best idea available. Interestingly, expected profit is decreasing in $\gamma_i$. The larger $\gamma_i$, the lower is the expected value of an idea. Even though the maximum is not affected, increasing variance and lowering the average value of an idea will ultimately reduce the expected value of the best available idea after $n$ periods.

Given our theory, we can derive predictions with regard to individual behavioral biases and preferences and their impact on individual creativity. We saw that the optimal number of ideas that an agent should generate depends on the individual precision of ideas. However, it is well known in the psychological literature and the economic literature on overconfidence, that individuals have overconfidence in judgement and tend to overestimate the precision of their information (see Russo and Schoemaker (1992)). Applied to our problem, this implies that agents form a belief $\hat{\gamma}_i$ about their individual $\gamma_i$, which may deviate from the true $\gamma_i$. Given that the number of actually generated ideas will depend on $\hat{\gamma}_i$, this may result in a suboptimal number of generated ideas and may ultimately lead to lower profits. In particular, overconfident agents who underestimate their $\gamma_i$ ($\hat{\gamma}_i < \gamma_i$) will show

too little engagement in the creative process and implement suboptimal ideas.

This prediction is related to theoretical work in financial market contexts with asymmetric information. For example, Benos (1998), Daniel, Hirshleifer, and Subrahmanyam (1998) and Odean (1998) show theoretically that this form of overconfidence can lead to poor performance. Also, Biais, Hilton, Mazurier, and Pouget (2005) show that judgemental overconfidence leads to reduced performance in an experimental financial market. We will use experimental methods to test the prediction that judgemental overconfidence is also harmful to innovative activity. Our experimental approach and our hypotheses are presented in the next two sections.

## *3.3 Experiment*

To test the predictions of our theory of innovative activity, we use an economic experiment in which participants have to solve a management task. In this task, innovating the product mix is central. A very similar task has previously been used by Ederer and Manso (2010), who studied the effects of different incentive schemes on innovative activity.[5] Since there is little knowledge about the external validity of experimental measures of innovative activity, we collected experimental data from two different subject pools: students and managers. For the manager sample, we were able to collect external on the job data on innovative activity in addition to the experimental data. We will use this data to provide evidence on the external validity of experimental measures of innovative activity in section 3.6.

### *3.3.1 Procedures and Subject Pool*

We recruited subjects from two different backgrounds. 35 of our subjects are middle managers of a financial industries company with approximately 550 employees. These managers participated in the experiment in the experimental laboratory at the Institute for Empirical Research in Economics at the University of Zurich. In addition, we recruited 119 subjects from a pool which primarily consists of students at Zurich University and the Federal Institute of Technology in Zurich.[6]

[5] The experimental design of Ederer and Manso (2010) has been the foundation of our experiment, and we are grateful to Florian Ederer for providing us with their original experimental code.

[6] Subjects were drawn from a database of volunteers using ORSEE (Greiner (2004)).

The experiments were programmed and conducted using the software z-tree (Fischbacher (2007)). The managers participated in three sessions in November and December 2009.[7] Student data was collected in a pilot in October 2009 (17 subjects) and three additional sessions in June 2010 (102 subjects).[8] A session lasted, on average, 90 minutes. During the experiment, experimental currency units called Taler were used to keep track of monetary earnings. The exchange rate was set at 75 Taler = CHF 1.[9] Subjects on average earned CHF 25 in the ice cream task and an additional 9 CHF in lotteries, that were played after the ice cream task was completed.

The manager sample is of particular importance, since we use it to externally validate our experimental task. After the managers participated in our experiment, we contacted their direct supervisors and asked them to fill out surveys which provided us with individual ratings of the managers' innovative activity and performance in the company. To ensure anonymity, we did not contact the supervisors directly, but through a third agency, which subsequently matched the survey data to the experimental data. This procedure guaranteed that neither we nor the financial industry company can link performance in the experimental task or the rating in the survey to the identity of a manager. In addition to the direct supervisor, we also asked the human resource department to fill out the survey for each manager who participated in the experiment. In total, we received 32 completed surveys from supervisors, and 26 completed surveys from the human resource department.[10]

### *3.3.2 The Ice Cream Stand Experiment*

In this experiment, participants took the role of a manager operating an ice cream stand. The experiment lasted 20 periods, and in each period participants

[7] The first session had 15 participants, the second 17, and the third 3.

[8] The number of participants differed across sessions. However, all experiments were individual decision experiments, so session size should not influence the results.

[9] In the pilot, the exchange rate was set to 100 Taler= CHF 1. Moreover, subjects in the pilot received a show-up fee of CHF 10. In all other sessions the show-up fee was set to 0. In the analysis, differences in the exchange rate are accounted for when observations from the pilot are included.

[10] For 3 managers, the direct supervisor was the company CEO, who did not complete the survey, due to time constraints.

made decisions on how to run the ice cream stand. There were six different strategic variables that could be changed in every period. Three variables were categorical: The location of the stand, the flavour of the ice cream and the ice cream color. The other three variables were continuous choices of the sugar content, the flavour intensity and the price. Participants had a predefined action space for all variables except for flavour. The price could be chosen between 0 and 10. Flavour intensity and sugar content could be chosen between 0 and 10 percent. Ice cream color was a binary choice between strong color and soft color. Three locations were available: The business district, the stadium and the school. Participants were free to choose a flavour of their liking, without predefined options.[11]

Every location had a unique bliss point yielding a location specific maximal profit. The location specific bliss points, as well as the maximally achievable profits at each location, are given in table 3.1.

*Table 3.1:* Optimal product mix and maximal achievable profit by location

| | Business District | School | Stadium |
|---|---|---|---|
| Sugar Content | 1.5% | 9.5% | 5.5% |
| Flavour Intensity | 7.5% | 1.5% | 5.5% |
| Colour | soft | strong | soft |
| Price | 7.5 | 2.5 | 7.5 |
| Maximum Profit (excluding Flavour) | 100 | 200 | 60 |

In order to calculate per period profits, a linear penalty function was used to subtract payoffs from the maximally achievable profit at the chosen location. The penalty factors associated with a deviation of one unit for each of the variables are given in table 3.2.

*Table 3.2:* Penalty factors for deviation from the optimal product mix

| | Business District | School | Stadium |
|---|---|---|---|
| Sugar Content | 5 | 6 | 0.5 |
| Flavour Intensity | 5 | 6 | 0.5 |
| Colour | 20 | 60 | 0.5 |
| Price | 5 | 6 | 0.5 |

[11] Flavours were predefined, but no information was given with regard to available flavours. If a non-predefined flavour was chosen, the subject had to choose another flavour.

We view creativity as an integral part of the innovation process. An innovation is a truly novel business strategy, idea, or technology which has not been available or known before. Therefore, innovation implies the discovery of novel options, which is different from just exploring available options. In order to capture this aspect of the innovation process, we extended Ederer and Manso's lemonade stand task and included the additional flavour dimension, which in turn caused us to switch from selling lemonade to selling ice cream. This is also the reason why no predefined options were presented to the subject for the flavour dimension.

The choice of flavour had an impact on profit that was independent of the location and reflected sales numbers in Germany in 2008.[12] We excluded the four most prominent flavours (Chocolate, Vanilla, Strawberry and Straciatella) to prevent an immediate clustering of flavour choices on these obvious alternatives.[13] Every flavour had an associated factor with which profits were multiplied in order to yield the ultimate profit. Table 3.3 shows these factors.

*Table 3.3:* The effect of flavour on profit

| Flavour | Factor |
|---|---|
| Lemon | 3.15 |
| Joghurt | 2.6 |
| Nut | 1.9 |
| Banana | 1.45 |
| Walnut | 1.4 |
| Cherry | 1.2 |
| Orange | 1.15 |
| Woodruff | 1.08 |
| Raspberry | 1 |
| Other | 0.9-1 |

Subjects got feedback during the experiment. At the end of each period, subjects learned the profits they obtained during that period. They also saw a customer reaction that contains information about the optimality of their choices. This feed-

[12] Information on sales numbers was received from E.I.S. Eis Infoservice der deutschen Markeneishersteller.

[13] Subjects were told that it is unprofitable to sell these flavours. Customers always by these flavours at another ice cream stand and will not deviate from that. Moreover, subjects could only offer pure flavours, and no mixtures of different flavours.

back was implemented by having the computer randomly select one continuous choice variable, the price, the flavour intensity or the sugar content, and a binary feedback with regard to that variable was provided to the subject. For example, if the computer selected sugar content and the subject has chosen a sugar content that is above the optimal level for the location chosen by the subject in that period, the feedback takes the form: "Many of your customers told you that the ice cream is too sweet". No feedback was given with regard to any of the other dimensions.

Subjects did not know the profits associated with each of the available choices. Attached to the instructions, however, there was a letter from the previous manager which is reproduced in the appendix. The letter gave hints to the subjects about a strategy that has worked for this manager. The strategy suggested by the previous manager involves setting the stand in the business district, selling orange ice cream, choosing a high flavour intensity, a low sugar content, a high price and a soft colour. The managers letter also stated that the manager has tried several combinations of variables in the business district location, but has never experimented setting up the stand in a different location. It also points out that he has never chosen a different flavour than orange. It further suggests that different locations may require a very different strategy, but that it is known to him that the effect of flavour on profits is independent of the location. The participants in the experiment thus faced the choice between fine-tuning the product mix given to them by the previous manager (exploitation) or choosing a different location or flavour, and radically altering the product mix to discover a more profitable strategy (exploration). The strategy of the previous manager was not the most profitable strategy. The most profitable strategy was to set the ice cream stand in the school district, sell lemon ice cream, to choose a low flavour intensity, a high sugar content, a low price and strong colour.[14] The payoffs in the game were chosen in such a way that without changing the default location the additional profits earned from improving the strategy in the business district are relatively small. The only sizeable increase in profit in the business district could stem from changing the flavour. On the other hand, changing the location to the school required large changes in at least two other variables to attain an equally high profit as suggested by the default strategy. In addition to the previous managers letter, the instructions contained a table in

[14] see table 3.1.

which subjects could input their choices, profits, and feedback in each period. Subjects are told that they can use this table to keep track of their choices and outcomes. Subjects were not paid for their performance in period 1-10. In periods 11-20, they received the acquired profits in every period.

Next, we present the experimental elicitation of judgemental overconfidence and several controls that relate to our model. In every experimental session, subjects first completed the ice cream task and then participated in a series of additional experiments to measure individual preferences, abilities and psychological factors. We measured a proxy for overconfidence in judgement and collected data on individual IQ, creativity and ambiguity aversion. Every additional experiment is described in the following subsections.

### *3.3.3 Judgemental Overconfidence*

To analyze the consequences of judgemental overconfidence on innovation and creativity, we adopt measurement tools from experimental psychology and use an established task originally developed by Lichtenstein, Fischhoff, and Phillips (1982). To assess judgemental overconfidence, Lichtenstein, Fischhoff, and Phillips (1982) and also Russo and Schoemaker (1992) use a confidence interval procedure in which participants are asked to make range predictions such that they are 90 percent sure that the actual value will fall within the range specified. Miscalibrated participants typically give ranges that are too narrow, such that actual values fall outside the range more than 10 percent of the time. A subject is then said to be more miscalibrated, or overconfident, the more answers lie outside the given bounds.[15] Biais, Hilton, Mazurier, and Pouget (2005) used the same assessment method for judgemental overconfidence to test its effect on performance in an experimental asset market and showed that miscalibration reduces trading performance. In accordance with the approach to judgemental overconfidence in psychology we hypothesize that the process underlying the formation of overconfident beliefs in the precision of generated ideas is similar to that underlying the formation of overconfident judgements when answering the calibration questionnaire, because both

[15] Evidence for the stability of individual differences in judgemental overconfidence has been provided by Klayman, Soll, Gonzalez-Vallejo, and Barlas (1999), Parker and Fischhoff (2005) and Jonsson and Allwood (2003)

reflect overestimation of the diagnosticity of informational cues. Hence, the miscalibration measure from the confidence interval experiment can be used as a proxy for judgemental overconfidence in idea generation in our analysis.

In this experiment, participants are asked to provide an upper and lower limit such that they are 90 percent sure that the correct answer is between the two. This was repeated for 10 different questions which are listed in the appendix. In line with the usual approach in this task, correct answers were not incentivized. While for rational participants the expected proportion of answers lying inside the confidence interval is 90 percent, in our sample the average proportion of answers inside the confidence interval was 41 percent. This shows that our participants exhibited overconfidence in their judgement. This result is comparable to Russo and Schoemaker (1992), who found that business managers had the correct answer within the stated range between 42 percent and 62 percent of the time, and the results of Biais, Hilton, Mazurier, and Pouget (2005), who find that students in London and Toulouse had the correct answer within the stated range in 36 percent of the time. In our econometric analysis, we use the degree of miscalibration of the participants - measured as the number of questions for which the true answers fall outside the stated range - as a a proxy for a subject's judgemental overconfidence. While the mean percentage of correct answers that fall outside the stated range in our 154 participants sample was 59%, the minimum was zero, the first quartile was 40%, the median was 60%, the third quartile was 70%, and the maximum was 100%, showing that overconfidence varies substantially across individuals.

### *3.3.4 Ambiguity Aversion*

Since the ice cream stand experiment confronts the participant with a decision environment that contains ambiguity, we additionally collected ambiguity aversion measures of our participants. Each participant was confronted with seven choices between different lotteries of the following form:

> You can choose between drawing a ball from urn 1 or urn 2. Urn 1 contains $X$ red balls and $20 - X$ blue balls. Urn 2 contains an unknown number of red and blue balls. If a red ball is drawn, you receive CHF 8. If a blue ball is drawn, you receive CHF 0. Which urn do you draw from?

The seven lotteries varied in the amount $X$ of red balls in urn 1. $X$ took on the values $X \in \{4, 6, 8, 10, 12, 14, 16\}$. One of the seven gambles was randomly selected and paid. These lotteries enable us to construct individual measures of ambiguity aversion. The number of red balls $X$ at which a subject starts to switch from urn 1 to urn 2 is an indicator of a participants' ambiguity aversion. For example, a participant that chooses urn 1 as long as $X > 10$ is classified as less ambiguity averse than a participant that chooses urn 1 as long as $X > 8$. On average, participants choose urn 1 if there are at least 10 red balls. This was also the median and modal switching point. Hence, on average, participants were not ambiguity averse in this task.[16]

### *3.3.5 Raven's IQ*

Every subject completed a version of the Raven Progressive Matrices test (Raven, Raven, and Court (2003)). The Raven Progressive Matrices test is a so-called culture-free IQ test because it does not depend heavily on verbal skills or other knowledge explicitly taught during formal education. Each matrix test item presents a pattern of abstract figures. The test taker must choose the missing part out of 8 predefined solutions. Each subject had a total of 12 minutes to complete twelve different patterns. Before subjects started these 12 patterns, they had to correctly solve two example patterns. In line with the usual methodology in this task, individuals are not paid according to performance. We use the number of correctly completed patterns as a measure of intelligence. On average, subjects correctly solved 7.6 out of 12 patterns in the Ravens IQ task. The maximum number of correctly solved patterns was 12, and the minimum was 2.

### *3.3.6 Creativity*

To our knowledge, creativity measures have not been used in economic experiments so far. The reason for this most likely is that existing tests of creativity are

[16] Three participants made inconsistent choices in the ambiguity aversion experiment. For example, a sequence of choices is labeled as inconsistent if a participant choose urn 1 for $X = 12$, urn 2 for $X = 10$ and again urn 1 for $X = 8$. No single switch point can be inferred from this choice sequence. We exclude these observations when using ambiguity aversion as an explanatory variable in the analysis.

very difficult to introduce into the standard laboratory setting in economics. Usually these tasks involve having the subject build or paint something that is subsequently rated with respect to creativity by external judges. This implies that these tasks have no objective and easy to measure outcome variable that can be used as a proxy for individual creativity.

We use a creativity task that provides an objective measure of individual creativity and is easy to implement in a standard laboratory setting. The task is called the four-word task and it measures verbal creativity. This task is part of the Verbal-Creativity-Test battery originally introduced by Schoppe (1975). We are aware that this is, at most, a proxy for the creativity which may be necessary for innovation. In this task, participants are given 4 letters, and they are asked to build as many sentences as possible, consisting of 4 words, where all four letters are used as the starting letter of one of these four words. Participants are given 2.5 minutes to complete this task. The experiment is then repeated for another 2.5 minutes using another combination of letters. The two combinations of letters were B-H-K-N and T-G-F-U. The total number of correct and non-repetitive sentences constructed by a participant is used as our measure of individual creativity. In line with the standard methodology in this task, no incentives were given for entering correct sentences.[17] The average participant was able to build a total of 7.3 correct sentences in the 5 minutes of the 4-word verbal creativity task.

## *3.4 Hypotheses*

The ice cream task allows us to study innovative activity in a laboratory setting. Each participant faces a trade-off between exploring previously untested strategies and exploiting known business strategies. Innovative activity is therefore expressed through exploring novel business strategies by radically altering the product mix. Our experimental data allows us to observe the extent to which a participant engages in such activities.

Our theory makes predictions with regard to the number of ideas that an agent generates while engaging in innovative activities. In the experiment, an idea is equivalent to the exploration of a novel and previously untested strategy. Ederer

[17] Whether a sentence fulfills the criteria for correctness is coded individually ex post.

and Manso (2010) defined the exploratory phase as the number of periods in which a participant is actively involved in the exploration of novel business strategies. We adopt their definition of the exploratory phase, and define that a participant enters an exploratory phase if he for the first time chooses a location that differs from the location chosen by the previous manager. The exploratory phase ends if a participant stops making substantial changes in the product mix of the three continuous variables, makes no changes in flavour or colour, or returns to the default location. To test the robustness of our results, we defined different thresholds that determine whether a change in one of the continuous variables counts as substantial. The threshold that we use in this paper is set to a change of at least .25 units in at least one of the variables. Changing that threshold does not qualitatively change the results. Also, including changes in flavour as the starting point of the exploratory phase does not qualitatively change the results.

A second measure of explorative behavior is the average subject specific standard deviation of the strategy choices in the three continuous variables, price, flavour intensity and sugar content. Achieving high profits at locations other than the business district requires to radically altering choices in these three categories. Hence, exploration is central for success of the innovative strategy. Average subject specific standard deviations are a direct measure of the extent to which a participant engaged in exploration within these variables.[18] Finally, a third measure of exploratory activity in the ice cream task is the number of different flavours that a participant explores.

Given our theoretical framework and our experimental measures of innovative and explorative activity, we can test our hypothesis that judgemental overconfidence influences innovative and explorative activity:

**Hypothesis 1** *Judgemental overconfidence will reduce individual creative efforts and lead to less exploration and shorter explorative phases in the ice cream stand experiment.*

Hypothesis 1 is based on our theoretical analysis in section 2.3. Judgemental overconfidence will ceteris paribus lead to a reduction in the number of ideas that a participant on average generates. Idea generation is best resembled by exploration

[18] Averaging the standard deviation of these three variables is admissible since the action space for all of them ranged between 0 and 10 in increments of .1.

in the ice cream stand task. If a participant assumes that he has found a close to optimal business strategy, he stops exploring alternative strategies. If the judgement of the optimality of the current business strategy is overconfidently biased, a participant will stop too early. Our experimental measurements of the exploratory phase, the standard deviation of the product mix choices and the number of explored flavours are therefore good proxies for a subject's innovative activity in this regard.

Ultimately, the effect of a biased idea generation process should also be visible in generated profits. If a subject explores suboptimal, profits should be negatively affected. We can test this prediction using the profit data from the ice cream stand task.

**Hypothesis 2** *Judgemental overconfidence will lead to the implementation of suboptimal business strategies and therefore have a negative impact on profits.*

## *3.5 Results*

Our theoretical framework predicts that judgemental overconfidence biases the number of generated ideas downwards and therefore decreases innovative and explorative activity. We can directly test this prediction in our experiment. The goal of every subject is to find the optimal business strategy for selling the ice cream. The larger the degree of judgemental overconfidence, the earlier a subject should believe that he has found the optimal business strategy. Therefore, a larger degree of judgemental overconfidence should lead to a decrease in observed exploration. As detailed in Section 3.4, several behavioral measures in the experiment allow us to test this prediction. Empirically, we find the following:

**Result 1** *Judgemental overconfidence reduces explorative and innovative activity in the ice cream task. The exploratory phase, the number of periods in which a subject keeps making significant changes to the product mix after having switched the location for the first time, is reduced by half a period per unit increase in the degree of judgemental overconfidence. In addition, average standard deviation of the continuous variables in the first ten periods is reduced by approximately 0.05 units and the number of explored flavours is reduced by .12 units in the degree of judgemental overconfidence.*

Table 3.4 presents regression results that relate our behavioral measures of explorative and innovative activity to judgemental overconfidence.

*Table 3.4:* Testing whether judgemental overconfidence reduces innovative activity

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Exploratory Phase | Average Standard Deviation | | Number of explored flavours |
| | | Period 1-10 | Period 11-20 | |
| Judg. Overconfidence | –0.504*** | –0.046* | –0.020 | –0.121* |
| | (0.135) | (0.027) | (0.014) | (0.066) |
| IQ | 0.287** | 0.030 | –0.019 | –0.141** |
| | (0.122) | (0.024) | (0.012) | (0.059) |
| Ambiguity Aversion | –0.106 | –0.010 | 0.010 | 0.180 |
| | (0.321) | (0.063) | (0.032) | (0.150) |
| Student (d) | 0.008 | –0.337*** | –0.127** | 0.014 |
| | (0.624) | (0.124) | (0.062) | (0.298) |
| Constant | | 1.368*** | 0.772*** | |
| | | (0.393) | (0.198) | |
| Adj. $R^2$ | | 0.041 | 0.042 | |
| Observations | 151 | 151 | 151 | 151 |

Student is a dummy variable for the student subsample.
Regressions (1) and (4) are Poisson regressions on count data.
For regressions (1) and (4), marginal effects are reported in the table.
Regressions (2) and (3) are OLS regressions.
Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Subjects that made inconsistent choices in the ambiguity aversion task are excluded.
Inclusion of these subjects does not qualitatively change the result.

Column (1) in table 3.4 shows the marginal effects of a Poisson regression of the length of the exploratory phase on judgemental overconfidence as well as several controls. We use a Poisson regression model because the length of the exploratory phase is count data of the number of periods in which a subject keeps exploring the product mix after having changed the location for the first time before turning towards fine tuning.[19] We find a highly significant negative impact of judgemental overconfidence on the length of the exploratory phase. Per additional wrong answer in the confidence interval task, a subject stops exploring almost half a period

[19] Using a Cox hazard rate model that analyzes the likelihood of ending the exploratory phase delivers qualitatively similar results.

earlier. This result is robust with respect to changes in the definition of the exploratory phase. Including changes in flavour as a starting point of the exploratory phase, or changing the threshold at which changes in the continuous variables no longer count as exploratory does not qualitatively change the result. Interestingly, IQ also has a positive impact on the length of the exploratory phase. Per additional correctly solved pattern in the Ravens Progressive Matrices test, the length of the exploratory phase is increased by 0.29 periods.

Column (2) reports results from an OLS regression on the average individual standard deviation of strategy choices of the three continuous strategic variables (price, flavour intensity and sugar content) in periods 1-10. Judgemental overconfidence has a negative impact on standard deviation, indicating that overconfidence reduces the degree of exploration within these variables. The same picture arises when looking at the standard deviation in the second half of the experiment (see column (3)), where judgemental overconfidence still has a (statistically insignificant) impact on the standard deviation (p=0.17). Students seem to be less explorative in this domain than our manager subsample. In the first as well as the second half of the experiment, students have significantly lower average standard deviations in their continuous variable choices than managers. However, this is the only significant difference that we observed between the two samples.

We use a Poisson regression model to examine the effect of judgemental overconfidence on the number of different ice cream flavours that a subject explored in the course of the experiment (see column (4)). We find that overconfidence in judgement leads to a significant reduction in the number of explored flavours. Per additional wrong answer in the confidence interval task, the number of explored flavours on average decreases by 0.12. Interestingly, our IQ measure also has a negative impact on the number of explored flavours. Per additional correctly solved pattern in the Raven's Progressive Matrices test, the number of explored flavours is reduced by 0.14.

The effect of judgemental overconfidence on explorative behavior is further illustrated in figure 3.2.

When splitting the sample at median overconfidence, it can be seen that the average standard deviation in the first 10 periods is .18 units smaller for the high overconfidence group (p=0.08 using a t-test). The same picture arises when looking at the length of the exploratory phase. The high overconfidence group on average

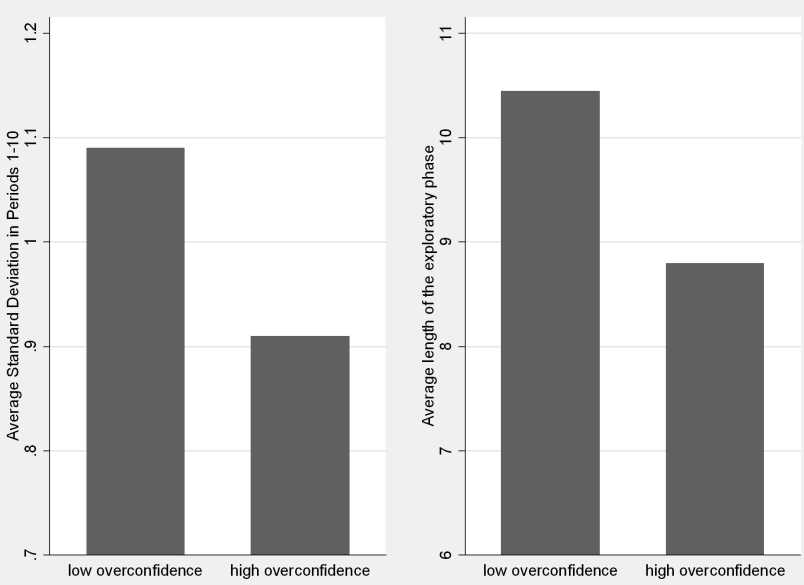



*Figure 3.2:* Average Standard Deviation in the first 10 periods of the game and average length of the exploratory phase, split at median judgemental overconfidence.

explores for 1.65 periods less than the low overconfidence group (p=0.02 using a t-test).

The cumulative evidence presented in table 3.4 and figure 3.2 suggests that judgemental overconfidence indeed has real consequences on innovative activity. Attributing too much precision to one's information is detrimental to innovative activity and reduces explorative efforts. Our initial hypothesis is therefore clearly confirmed by the data.

Our theory predicts not only that judgemental overconfidence reduces innovative activity, but that it will ultimately harm profits. According to the theory, the reduction in innovative activity leads to the implementation of suboptimal ideas because subjects underestimate the profitability of continued exploration. If this is not the case, the economic importance of the bias would clearly be limited. Moreover, profits are a comprehensive measure of the success of the business strategy and of innovative activity, and it measures how close a subject ultimately came to the optimal strategy mix. Empirically we find that:

**Result 2** *Judgemental overconfidence negatively effects subject earnings in the ice cream*

*task. For every additional wrong answer in the miscalibration task, profits decrease by 0.4 CHF. Using a robust regression, the effect is 1.0 CHF. The same picture arises when looking at the maximum per period profit that a subject achieved during the experiment. Using robust regression techniques, maximum per period profit on average decreases by 8.7 points per degree of judgemental overconfidence.*

Table 3.5 presents results from OLS and robust regressions of achieved earnings and maximum per period profits on our explanatory variables.

*Table 3.5:* Analysis of the effect of judgemental overconfidence on profits in the ice cream task

| | OLS Regressions | | Robust Regressions | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Subject Earnings (CHF) | Max. Period Profit (Points) | Subject Earnings (CHF) | Max. Period Profit (Points) |
| Judg. Overconfidence | –0.499 | –3.500 | –0.994* | –8.713* |
| | (0.695) | (5.844) | (0.561) | (4.775) |
| Creativity | 0.443 | 4.646 | 0.139 | 0.953 |
| | (0.357) | (3.000) | (0.288) | (2.451) |
| IQ | 0.415 | 0.254 | 0.168 | –1.525 |
| | (0.625) | (5.254) | (0.505) | (4.293) |
| Ambiguity Aversion | 0.009 | –2.525 | –0.476 | –1.597 |
| | (1.601) | (13.454) | (1.292) | (10.993) |
| Student (d) | 1.319 | 4.058 | 0.407 | 6.364 |
| | (3.139) | (26.385) | (2.534) | (21.557) |
| Constant | 21.626** | 214.986** | 27.879*** | 246.804*** |
| | (10.145) | (85.280) | (8.192) | (69.675) |
| Adj. $R^2$ | –0.011 | –0.012 | –0.007 | –0.007 |
| Observations | 151 | 151 | 151 | 151 |

Student is a dummy variable for the student subsample.
Regressions (1) and (2) are OLS regressions.
Regressions (3) and (4) are robust regressions to account for outliers.
Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Subjects that made inconsistent choices in the ambiguity aversion exp. are excluded.
Inclusion of these subjects does not qualitatively change the result.

We postulated that judgemental overconfidence leads to a decrease in innovative activity which ultimately hurts achieved profits. Our regression estimates in-

deed reveal a negative relationship between judgemental overconfidence and performance in the task. Using OLS regressions (column (1) and (2) of table 3.5), the effect of judgemental overconfidence on subject earnings as well as the maximum per period profit is negative, but not significantly so. However, the size of the regression coefficient is strongly influenced by a few outliers, which have very high achieved profits and simultaneously very high levels of judgemental overconfidence. Since OLS regressions are very sensitive to such outliers, we included robust regressions, which have the advantage that they are less sensitive to outliers (column (3) and (4) of table 3.5). In the robust regressions, the coefficient on judgemental overconfidence is large and significant at the 10 percent level. For every additional question in the miscalibration task, in which the true answer was not contained in the bounds given by the individual, profits in the ice cream task decrease by 1.0 CHF. Moreover, the maximum per period profit on average decreases by 8.7 points per degree of overconfidence.

These results suggest that judgemental overconfidence indeed has an impact on realized profits from innovation through its effect on decreased innovative activity. This relates to other recent evidence in economics that overconfidence in ability, measured as overconfidence in the probability of successful implementation, increases innovative activity. Our results therefore demonstrate that overconfidence can affect innovations in many ways. While overconfidence in ability leads to increased innovative activity and potentially to the implementation of suboptimal strategies because of overestimation of the expected returns from the innovation (see Galasso and Simcoe (2010)), our results point out that overconfidence in precision, which is fundamentally different from overconfidence in ability (see Hilton, Regner, Cabantous, Charalambides, and Vautier (forthcoming)), leads to a decrease in innovative activity and to the implementation of suboptimal ideas because subjects do not explore the product space sufficiently, i.e. they do not innovate enough.

## *3.6 External Validity of the Experimental Task*

An advantage of our data set is that it contains data on a manager as well as a student subsample. For the manager subsample, we are able to relate the experimental measures of innovative activity to external measures of innovative activity in the company.

### 3.6.1 External Datasources

We administered online surveys to the direct supervisors of each manager who participated in the experiment. In addition to the supervisors, the HR department filled out identical questionnaires as a robustness check of the data. Every manager was rated in five different categories: Taking charge behavior, action orientation, gestalt motivation, creativity and performance.[20] 32 supervisors filled out these surveys and returned them. 26 surveys were returned from the HR department.[21] Table 3.6 shows correlations between the HR-ratings and the supervisor ratings. The correlations are generally high ($\rho = 0.46 - 0.66$) and significant, with the exception of the action orientation ratings.

*Table 3.6:* External Data Questionnaires

| **Questionnaire** | **Source** | **Correlation**$^*$ |
|---|---|---|
| Taking charge | Morrison and Phelps (1999) | 0.66*** |
| | | (0.001) |
| Action orientation | Hossiep and Paschen (2003) | 0.32 |
| | | (0.132) |
| Gestalt motivation | Hossiep and Paschen (2003) | 0.62*** |
| | | (0.002) |
| Creativity | own items | 0.46** |
| | | (0.027) |
| Performance | own items | 0.64*** |
| | | (0.001) |

$^*$ Correlation reports the pair-wise correlation coefficient between the supervisor and the HR rating. P-values are reported in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

The first questionnaire, Taking Charge, is measured via an established questionnaire from the management literature (Morrison and Phelps (1999)). The Taking Charge questionnaire is originally filled out by co-workers, and therefore particularly suitable for our supervisor evaluation. Taking Charge is defined as "Constructive efforts by employees to effect functional change with respect to how work is executed". Taking charge is measured with a 10-item questionnaire on a 5-point

[20] All items of the surveys are reproduced in the appendix.

[21] One rated manager did not participate in the experiment.

Likert scale, and has previously been associated with innovative behavior in the company (see Unsworth (2001)). It has previously been found that taking charge behavior is positively related to felt responsibility, self-efficacy, and perceptions of top management openness. While taking charge is originally developed as a pro-active personality and initiative measure, there is now increasing convergence in the fields of innovation and self-initiative research which closely link the concepts and argue that initiative and pro-activity are necessary determinants of innovative activity (see Unsworth and Parker (2003)).

The second rated category was the action orientation of the employee. Action orientation is measured with 9 items on 7-point Likert scales. The third category measured gestalt motivation with 12 items on 7-point Likert scales. The action orientation and gestalt motivation items were adopted from the "Bochumer Inventar zur berufsbezogenen Persoenlichkeitsbeschreibung" (Hossiep and Paschen (2003)), which is the most widely used psychological assessment of job related personality characteristics in Germany.[22] Gestalt motivation is defined as the ability to have a self starting, pro-active work approach and having the motivation to change processes and situations according to one's own agenda. It therefore nicely relates to innovation and creativity within organizations. It describes the attitude to actively create and change the environment and organizational processes the employee is involved in, and therefore nicely captures the incremental innovations to organizational processes that every employee can achieve.

In the fourth category, the employee's creativity was assessed with a 4 item questionnaire on 7-point Likert scales. The fifth category assessed the overall performance of the manager in the company. This questionnaire was based on 4 items on 7-point Likert scales. Both of these questionnaires were developed by us. All questions can be found in the appendix. Since more data is available for supervisor ratings and since supervisors are in general better capable of monitoring the manager's activities during everyday business, we focus on supervisor ratings in our analysis below.

Table 3.7 summarizes the scores achieved in the different surveys. The score for each survey is standardized between 0 and 1.

[22] Usually, this is a self-report questionnaire. We rephrased the items such that the ratings relate to a third person

*Table 3.7:* Summary Statistics of Supervisor Ratings

| Variable | Mean | Std. Dev. | Min. | Max. | N |
|---|---|---|---|---|---|
| Creativity | 0.651 | 0.229 | 0 | 1 | 32 |
| Gestalt Motivation | 0.749 | 0.16 | 0.375 | 1 | 32 |
| Action orientation | 0.664 | 0.173 | 0.241 | 0.944 | 32 |
| Taking Charge | 0.709 | 0.153 | 0.325 | 1 | 32 |
| Performance | 0.694 | 0.207 | 0.292 | 1 | 32 |

The table reports summary statistics of a transformed measure that reflects the percentage of points that could be achieved in the reported measure.

Given our external data sources, we can analyze the relationship between them and our experimental measurements.

**Hypothesis 3** *External measures of creativity, taking charge behavior, gestalt motivation, action orientation and performance correlate positively with experimental measures of innovative activity.*

### *3.6.2 Results*

Our manager sample gives us the unique opportunity to externally validate the experimental evidence presented in section 2.4. Is it admissible to relate explorative behavior and achieved profits in the experimental ice cream task to innovative activity in companies? Given that we were able to collect external data from direct supervisors of the managers, we can combine experimental data with external measures of innovative activity. Empirically, we find that:

**Result 3** *Profit measures in the Ice Cream Task are strongly correlated with performance, creativity and gestalt motivation measures in the company. The profit measures are also strongly correlated with taking charge behavior. Hence, the ice cream stand task is a valid tool to experimentally analyze innovative activity of individuals.*

Table 3.8 shows pair wise correlation coefficients between different profit measures and the employee ratings in the external surveys. First of all, it is noteworthy that every single correlation coefficient is positive, indicating that performance in the experimental task is directionally consistent with our external measures. Manager creativity is significantly correlated with both profit measures in the ice cream

*Table 3.8:* Pairwise Correlations between experimental measures and external survey measures

| | Creativity | Gestalt motivation | Action orientation | Taking Charge | Performance |
|---|---|---|---|---|---|
| Profit Period 11-20 (CHF) | 0.33* (0.07) | 0.44** (0.013) | 0.23 (0.22) | 0.44** (0.014) | 0.49*** (0.005) |
| Max. Period Profit (Points) | 0.34* (0.06) | 0.46*** (0.009) | 0.28 (0.13) | 0.46*** (0.009) | 0.51*** (0.003) |
| Observations | 31 | 31 | 31 | 31 | 31 |

The table reports pairwise correlation coefficients.
p-values are reported in parentheses below the correlation coefficient.
Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

task, subject earnings over the last ten periods in the experiment as well as the maximum per period profit achieved by a subject throughout the experiment. The same picture arises when looking at gestalt motivation. Every single profit measure is highly positively correlated with the reported gestalt motivation (the correlation coefficient is always above 0.4) and the correlations are always significant at least at the 5 percent level. The relationship between action orientation and our experimental task is less clear. The correlation coefficients are lower (between 0.2 and 0.3), and not statistically significantly different from zero.[23] When looking at the correlation with taking charge behavior, the performance in the experimental task is again highly predictive. Correlation coefficients range between 0.4 and 0.47, and statistical significance is always at least at the five percent level. The experimental profit measures also correlate positively with the overall performance rating in the company. Overall, the performance measures in the experimental task are highly correlated with the external evaluations of creativity, gestalt motivation, taking charge behavior and performance. This is evidence that behavior in management games like our ice cream task is an admissible proxy for innovative activity

[23] Remember that action orientation was also the only category in which the correlation between the HR and supervisor ratings was low. Probably our external measure of action orientation is very imprecise. Alternatively, it could be that action orientation is not an individual characteristic that is of particular importance in the experimental task.

in companies.[24]

We can also perform a direct test of our model predictions using our external data source. The statistical power of such a test is however limited due to our reduced sample, limited data availability and the fact that there is noise in our experimental measures as well as our external measures which reduces our chances to find significant effects. Nonetheless, it is worthwhile to explore whether judgemental overconfidence also has an impact on external ratings.

*Table 3.9:* The Effect of Judgemental Overconfidence on External Ratings

| | (1) Creativity | (2) Gestalt Motivation | (3) Taking Charge | (4) Performance |
|---|---|---|---|---|
| Creativity (4-Word) | –0.028 | –0.024 | 0.038 | 0.048 |
| | (0.048) | (0.060) | (0.046) | (0.052) |
| IQ | 0.073 | 0.074 | 0.121 | 0.050 |
| | (0.099) | (0.135) | (0.115) | (0.122) |
| Judg. Overconfidence* | –0.147 | –0.262 | –0.222 | –0.588* |
| | (0.254) | (0.337) | (0.301) | (0.319) |
| Ambiguity Aversion | –0.271 | –0.061 | –0.084 | –0.134 |
| | (0.174) | (0.204) | (0.219) | (0.165) |
| Constant | 0.952 | 0.059 | –0.558 | 0.228 |
| | (1.002) | (1.021) | (1.079) | (0.949) |
| Adj. $R^2$ | –0.007 | –0.110 | –0.024 | 0.038 |
| Observations | 31 | 31 | 31 | 31 |

Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Standard errors are in parentheses and clustered at the supervisor level.
* Judgemental Overconfidence is a Dummy Variable that takes on the value 1 for above median overconfidence.

To reduce the effects of noise on our results, we split our sample into a high and a low judgemental overconfidence group. Table 3.9 reports regression results for our external measures. It can be seen that judgemental overconfidence negatively affects ratings in all dimensions, and significantly so in the performance

[24] In the appendix, we report results from OLS regressions. We regress the score in every category separately on every single profit measure, and cluster standard errors on supervisors (20 different supervisors are responsible for the 31 ratings). Significance of the regression coefficients is approximately in the same range as the pair-wise correlations reported here, which do not use clustered standard errors.

category. Even though statistical significance is weak, our external datasets seem to be consistent with the model predictions and the relevance of judgemental overconfidence for innovative activity.

## *3.7 Conclusion*

In this paper, we developed a model of innovative activity that focuses on the creative phase of the innovative process. Based on the model we derive predictions that innovative activity is negatively affected by judgemental overconfidence. In an experimental management game in which innovation is achieved through exploration, we find that judgemental overconfidence indeed negatively affects innovative and explorative activity, and has a negative impact on realized profits from innovation. In addition, we provide evidence that experimental measures of innovative activity have external validity. Using a subsample of managers for which we also received external data on innovative activity at the workplace, we show strong correlations between performance measures in the experimental task and the supervisor ratings of innovative activity at the workplace.

Our results contribute to the understanding of the individual determinants of innovative activity. We show that innovative and explorative activity is significantly reduced in the degree of judgemental overconfidence, and that judgemental overconfidence ultimately leads to lower profits from innovations. Previous work on the effects of overconfidence in ability has shown that this other form of overconfidence leads to more innovation. Our results therefore show that different forms of overconfidence have directionally opposing effects on innovative activity, and we point out another important psychological aspect that determines innovative activity.

Our results have implications for optimal innovation practices in organizations. Given that judgemental overconfidence is fairly prevalent among humans, it is important for companies to encourage researchers to extend the exploratory phases during the innovation process. This way, the likelihood of implementing premature innovations due to judgemental overconfidence is reduced.

The second main contribution of this paper is the provision of evidence that experimental measures of innovative activity have external validity. The laboratory offers an ideal environment to study the personal and institutional determinants of

innovative activity. Establishing external validity of the results is therefore important. It is suitable for answering additional questions with respect to innovative activity such as the impact of competition, patent laws or trade secrets on innovative activity. It may also allow the identification of personality characteristics and traits of innovative individuals. Even though we provide initial evidence on the external validity, more research and additional tests of the external validity of laboratory measures of innovation is certainly desirable. We are confident that the framework presented in this paper will prove useful in this regard.

# APPENDIX

# A. APPENDIX TO CHAPTER 1

## *A.1 Instructions*

# Instructions for Participant A

You are now participating in a scientific study. A research foundation has provided funds for conducting this research. Please read the following instructions carefully. The instructions inform you about everything you need to know to participate in the study. If you do not understand something, please call for an instructor, he will answer you question at your place.

Before the study begins you receive a show up fee of **10 Swiss Francs.** During the study you may earn additional money by making **Points.** The amount of points you earn during the study will depend on you decisions and the decisions of other participants.

All points that you earn during the study will be converted to Swiss Francs at the end. The conversion rate is

**10 Points = 1 Swiss Franc**

**At the end of the study you will receive the amount of money that you earned during the experiment plus the 10 Swiss francs show up fee.**

During the study, it is strictly forbidden to communicate with each other. In addition, please do only use those functions on your computer, which relate directly to the study. Communication or using the computer in a study-unrelated way will lead to exclusion from the study. If you have questions we are happy to assist you.

This study consists of two parts:

1. Part:

The first part of the study lasts for **7 periods.** The first two of these are practice periods and won't be paid. In this part of the study you make decisions on your own and you decisions have no consequences for other participants. Equally, the decisions of the other participants have no consequences for you.

2. Part:

In the second part of the study, there are two types of participants. Participant A and Participant B. **During the whole study you will be a Participant A.**
The second part of the study lasts for 10 periods. In each period you are matched with another participant B into a group. Nobody will at any time be informed who has been together in a group with whom.

The detailed course of the first part is very similar to the course of the second part of the study. For this reason, the instructions will first focus on the second part of the study. At the end of the instructions, the specific details about the first part will be given.

# Short overview of the study (2. Part)

In this part of the study you will in each period form a group with another participant B. In each period, one out of 35 cards has to be chosen. Initially, you and participant B see these cards covered on your screen. Just one card is turned around and visible for you and Participant B, the **Green Card**. All other cards are reshuffled at the beginning of every period and laid out at a random position. In each round, there are two more cards which yield positive payoffs: **The Red Card and the Blue Card**. All other cards are Blanks.

In total, the second part consists of 10 periods. The course of each period is as follows:

1. In each period, as Participant A you have the right to decide at the end of the period, which card position is chosen.
   - o You can keep the right
   - o Or you can transfer the right to Participant B. In this case, Participant B has the right to decide at the end of the period, which card position is chosen.

2. After you either kept or transferred the decision right to Participant B, you and Participant B can, separately from each other and against a cost, search for the Red and Blue Cards.

   - o If your search is successful, you will be informed about the positions of the Red and Blue card.
   - o If your search is unsuccessful, all cards but the Green card remain covered.

The same conditions apply to participant B. However, you will not be informed about the success of B's search. Equally, B will not be informed about the success of your search.

3. The participant without decision right can recommend a card position to the other participant. The recommendation will be transmitted to the participant who holds the decision right, before he makes his decision.

4. The participant with decision right chooses a card.

5. You and participant B are informed about your incomes in this period.

# Detailed Description

### The Setup

The screen below shows the cards at the beginning of each period. 35 cards are reshuffled in each period and place at a random position. Only **the Green Card always remains at position 18** and is visible for you and participant B:

### The Cards

In each round there are four kinds of cards. You know exactly at which position

| | | | | | | |
|---|---|---|---|---|---|---|
| Position 1 ? | Position 2 ? | Position 3 ? | Position 4 ? | Position 5 ? | Position 6 ? | Position 7 ? |
| Position 8 ? | Position 9 ? | Position 10 ? | Position 11 ? | Position 12 ? | Position 13 ? | Position 14 ? |
| Position 15 ? | Position 16 ? | Position 17 ? | Position 18 GRÜNE KARTE | Position 19 ? | Position 20 ? | Position 21 ? |
| Position 22 ? | Position 23 ? | Position 24 ? | Position 25 ? | Position 26 ? | Position 27 ? | Position 28 ? |
| Position 29 ? | Position 30 ? | Position 31 ? | Position 32 ? | Position 33 ? | Position 34 ? | Position 35 ? |

the **Green Card** is. In addition, there is **a Red Card, a Blue Card, and 32 Blanks.** These are covertly placed at a random position. At the end of each period, you or Participant B chooses one of these Card Positions. Each card has certain payment consequences for you and participant B:

- Blanks: You and participant B get 0 points.
- The Blue Card: You get 35 points, Participant B gets 40 points
- The Red Card: You get 40 points, Participant B gets 35 points
- The Green Card: You get 10 points, Participant B gets 10 points

Card Overview

| Card | Your Earnings | Earnings Participant B |
|---|---|---|
| Blue | 35 | 40 |
| Red | 40 | 35 |
| Green | 10 | 10 |
| Blank | 0 | 0 |

**1. Step: You can transfer or keep the decision right**

Either you or participant B chooses a card position at the end of the period. The chosen card determines the earnings of you as well as participant B.
At the beginning of each period you hold the decision right. You can

- Keep the decision right
- Transfer the decision right

If you keep the decision right, you make the final decision about the chosen card. If you transfer the right, Participant B makes this decision.

**2. Step: The search for cards**

In each period, you can search fort he Blue and the Red cards. **If your search is successful, all cards will be turned and you know the positions of the Red and Blue Card.** If your search is unsuccessful you will, as before, only know the position of the Green Card, all other cards remain covered.
Participant B also has the possibility to search for the Red and the Blue Card. Your search and the search of Participant B are completely independent from each other. You do not know, whether participant B searched successfully, and Participant B does not know whether you searched successfully.

If for example participant B searched successfully but you did not, only participant B is informed about the position of the Red and the Blue Card. You do not receive this information.

**How does search work?**

You and Participant B can independently from each other **choose a search intensity between 0 and 100. The search intensity equals exactly the probability, with which all cards are turned.**

$$0 \leq \text{Search Intensity} \leq 100$$

A search intensity of 0 therefore means that the cards will be NEVER turned. A search intensity of 100 means, that the cards will be ALWAYS turned. For intermediate values it may happen that the cards are turned or not

**The cost of search**

The higher you choose the search intensity, the higher are your costs. The costs of participant B are identical to your costs. The following table shows the costs for every possible search intensity. It is only possible to choose search intensities in increments of 5.

| Search intensity | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Costs in points | 0 | .06 | .25 | .56 | 1 | 1.56 | 2.25 | 3.06 | 4 | 5.06 | 6.25 |

| Search intensity | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| Costs in points | 7.56 | 9 | 10.56 | 12.25 | 14.06 | 16 | 18.06 | 20.25 | 22.56 | 25 |

**Please always consider this table when you choose search intensities. Your costs will remain the same throughout the experiment.**

The following always holds:
The higher you choose the search intensity, the more likely it is that the cards will be turned and you are informed about the position of the Red and the Blue Card. But your costs are also higher, the higher you choose the search intensity

**The Success of Search:**

The Computer determines, using your chosen search intensity, whether the cards will be turned or not. This works as follows:

Your chosen search intensity is between 0 and 100. The computer then randomly draws one out of a hundred balls, which are numbered from 1 to 100. If the drawn number is smaller or equal your chosen search intensity, all cards will be turned. Id the number larger then your search intensity, no card will be turned. Hence, the search intensity equals exactly the probability with which all cards will be turned.

Examples:

1. You choose a search intensity of 15:

If the randomly drawn ball has a number between 1 and 15 (=15 out of 100 balls) all cards will be turned. If the number is larger than 15 (16-100, and therefore 85 balls), no cards will be turned.

2. You choose a search intensity of 75:

If the randomly drawn ball has a number between 1 and 75 (=75 out of 100 balls) all cards will be turned. If the number is larger than 75 (76-100, and therefore 15 balls), no cards will be turned.

At no point in time will you be informed about the search intensity of participant B. Equally, participant will ever be informed about your search intensity.

If your search was successful, all cards will be turned and you know the positions of the Red and the Blue cards. You will then see the following screen (example):

| | | | | | | |
|---|---|---|---|---|---|---|
| Position 1<br>0 | Position 2<br>0 | Position 3<br>0 | Position 4<br>0 | Position 5<br>0 | Position 6<br>0 | Position 7<br>0 |
| Position 8<br>0 | Position 9<br>ROTE KARTE | Position 10<br>0 | Position 11<br>0 | Position 12<br>0 | Position 13<br>0 | Position 14<br>0 |
| Position 15<br>0 | Position 16<br>0 | Position 17<br>0 | Position 18<br>GRÜNE KARTE | Position 19<br>0 | Position 20<br>0 | Position 21<br>0 |
| Position 22<br>0 | Position 23<br>0 | Position 24<br>0 | Position 25<br>0 | Position 26<br>0 | Position 27<br>0 | Position 28<br>0 |
| Position 29<br>BLAUE KARTE | Position 30<br>0 | Position 31<br>0 | Position 32<br>0 | Position 33<br>0 | Position 34<br>0 | Position 35<br>0 |

**3. Step: The recommendation**

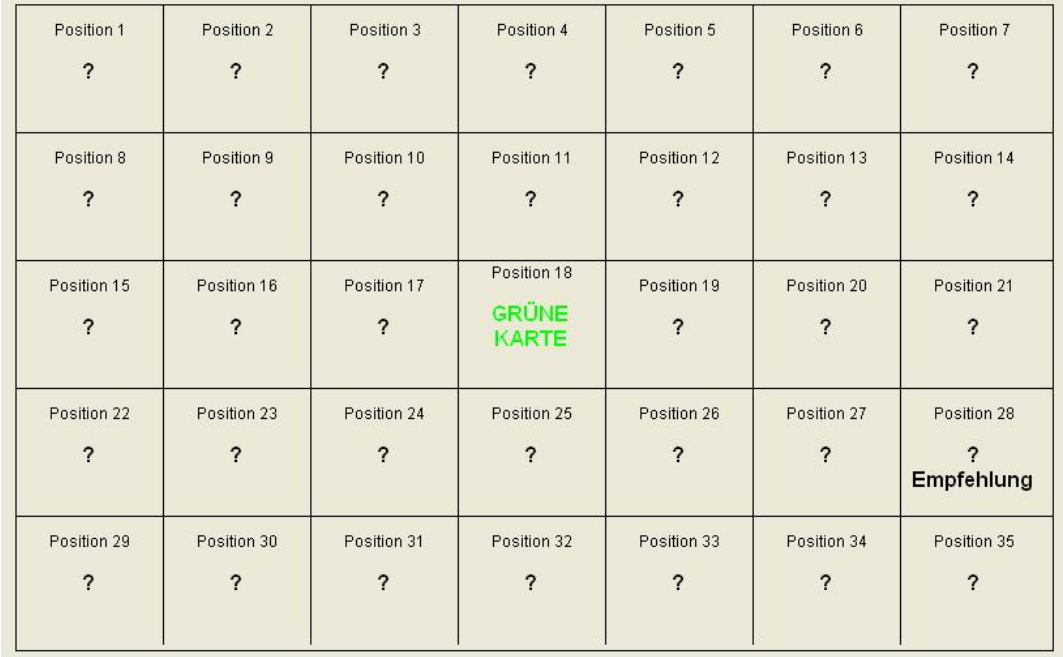
After the search, the participant without decision right can **recommend a card position** to the other participant.

- If you transferred the decision right, you can send a recommendation to Participant B.
- If you kept the decision right, Participant B will send a recommendation to you.

Depending on the success of the search of the recommender, he is either informed about the positions of all cards or only knows the position of the Green card. Independent thereof he can recommend any position.

The participant with decision right is only informed about the recommended Card Position, and not, which card it is.

The following screen shows an example, how the recommendation is transmitted to the participant with decision right. (In the shown example the search of the participant with decision right was unsuccessful):




**4. Step: Choosing a card:**

The participant with decision right can decide at the end of each period, which card is chosen.

- If you kept the decision right, you make this decision.
- If you transferred the decision right, participant B makes this decision.

If the search of the participant with decision right has been successful, he knows the position of the Red and the Blue card. If search was unsuccessful, he does not know these positions. In addition, he knows the recommendation of the other participant.

The participant with decision right can then, with this information, choose a card and the participants earn the points associated with that card minus the costs of search.

**The Incomes**

The income of both participants is determined by the following two parts:

- The income associate with the chosen card
- Minus the costs of search

**Income in a period = Income from chosen Card – Costs of search**

**Notice:**
In each period you may make losses! These losses will be subtracted from your show up fee.
You make a loss in a period if your search costs exceed your earnings from the chosen card.

Example:

Assume you chose a search intensity of 50. This costs 6.3 points. Assume further, that the participant with decision right chooses a Blank. Your earnings from the card is 0. Hence, your income in that period would be -6.3.

**Summary of one Round**

1) At the beginning of every period you decide, whether you want to transfer the decision right to participant B or whether you want to choose a card yourself.
2) Thereafter you and participant B can, independent of each other and against a cost, search for the position of the Red and the Blue Cards.
3) Both participants are informed about the success of their own search. They do not get any information about the search and the success of the other participant.
4) The participant without decision right can recommend a card position to the participant with decision right
5) The participant with decision right receives the recommendation of the other participant. Thereafter he can choose the final card.
6) The earnings associated with the chosen card are realized, and you and participant B are informed about your incomes.
7) You are randomly matched with another participant B, and a new round starts.

**The first part of the study:**

1) In the first part of the study, you are NOT in a group with a participant B. Hence, you always have the right to decide, which card is chosen. You cannot transfer it.
2) In each period you choose a search intensity, to find the positions of the Blue and the Red card. The cost of search and the earnings associated with the cards are identical to the second part of the study.
3) You are informed about the success of your search and you can choose a card. Since there is no second participant, there is also no recommendation.
4) The earnings associated with the chosen card are realized. Only the payment to you (participant A) is relevant. Since there is no participant B, only your points are paid out.
5) The first two periods are for practice purposes only, so you can get familiar with the program. You earnings from these two periods will not be paid out.

Your income from the following 5 periods, together with your income from the 10 periods in the second part of the study, will be paid out to you at the end of the study.

## Computer Program Description

This study consists of 17 periods. In the first 7 periods (first part of the study), only some of the decisions explained below are relevant. The description follows the steps in the second part of the study. In the second part, in every period you are in a group with another participant B.

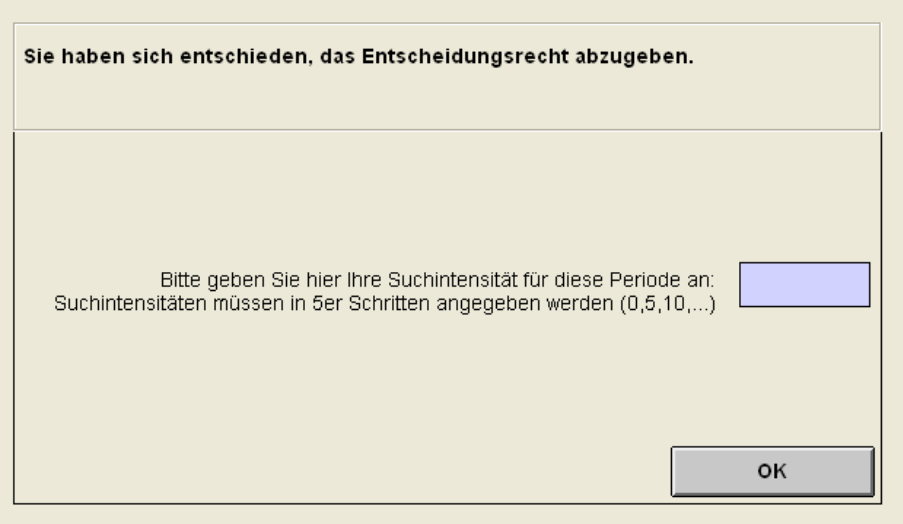
### 1. Step: You can transfer or keep the decision right

On the first screen you make the decision whether you want to keep or transfer the decision right to participant B in that period.


Click on the button ABGEBEN if you want to transfer the decision right to participant B, or click on the button BEHALTEN, if you want to keep the decision right. If you made your decision, please click to OK button. As long as you did not click on the OK button, you can change your decision.

### 2. Step: The Search

After you made your decision, participant B is informed about the chosen distribution of the decision right. Then, you both can choose your individual search intensities. The higher you choose your search intensity, the more likely it is, that you will be informed about the positions of the Blue and the Red Card. But your Costs are also higher, the higher you choose the search intensity. You make your decision about your search intensity on the screen shown below (in this example for the case, in which you transferred the decision right):



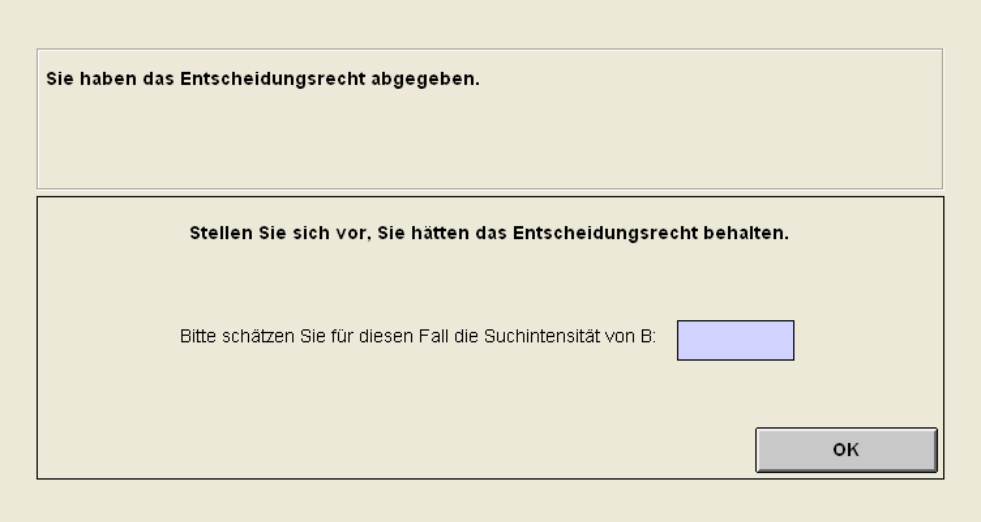

After you entered your search intensity, this intensity and the associated costs are shown to you again. If you want to change your decision, click on “Change Search Intensity”. Otherwise click OK.

### 3. Step: Estimate of the search intensity of the other participant

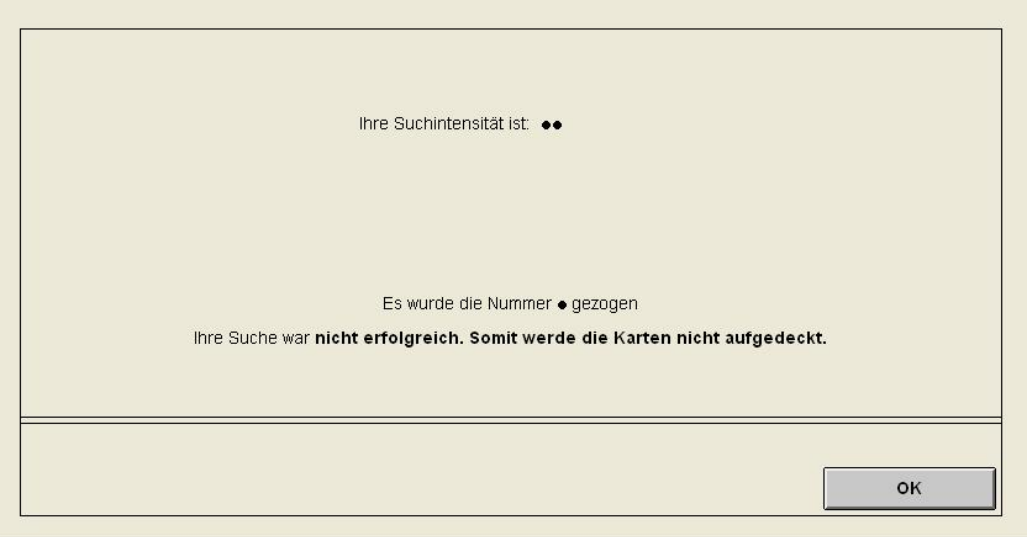
In addition to the choice of your search intensity we would like to know from you, what your estimate of the search intensity of participant B is. Independent of whether you transferred the decision right to him, we would like to know your estimate for both situations:

1. What search intensity does participant B choose, if you transferred the decision right to him
2. What search intensity does participant B choose, if you kept the decision right

You enter your estimate on the screen shown below (the screen shows an example of one of the situations, which is asked for):



After both participants chose their search intensities, the success of search is determined. The following screen shows, how you are informed about the success of search:

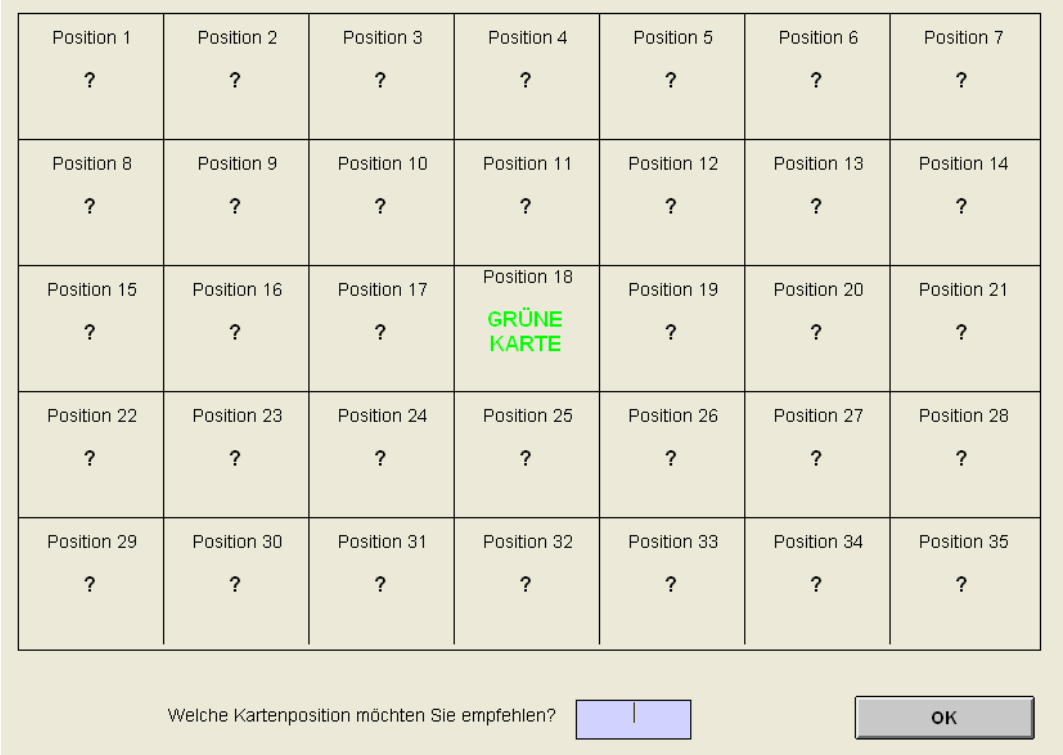



You see your search intensity as well as the number the computer randomly determined. If your search intensity is larger then this number, your search was successful. In this case, you will be informed about the position of the red and the blue card. If your search is unsuccessful, you will not be informed about these positions. In the example above search has been unsuccessful.

### 4. Step: The Recommendation

Thereupon the participant without decision right can make a recommendation. He can recommend one position to select. This position will be transmitted to the participant with decision right.

In case, you make your recommendation on the screen shown below:




If your search has been successful, you will see the exact positions of the Red and the Blue Card. Otherwise, you only see the position of the Green Card. On the shown screen, search has been unsuccessful. Please enter the Card position you want to recommend to the other participant into the field “Which Card position would you like to recommend?” You can choose each position, including the position of the green card (position 18).

After you made your decision, please click OK and confirm your selection.

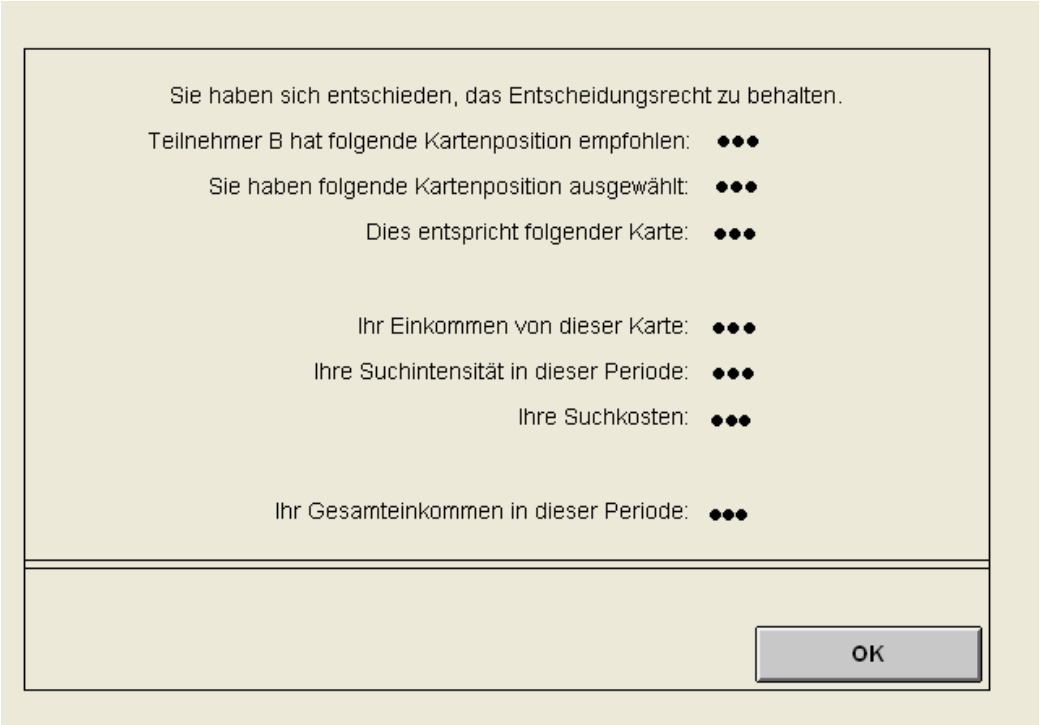
**5. Step: The Decision**

If you kept the decision right, you receive the above described recommendation from participant B. You then make the final decision, which card position is chosen. You make this decision on the following screen:


If your search has been successful, you will see the exact positions of the Red and the Blue Card. Otherwise, you only see the position of the Green Card. On the shown screen, search has been unsuccessful. In addition, you see the recommendation from the other participant. On the shown screen, position 12 has been recommended. Please enter the Card position you want to choose into the field “Which Card position would you like to select?” You can choose each position, including the position of the Green Card (position 18).
After you made your decision, please click OK and confirm your selection. Your selection then determines the payoffs for you and participant B in that round.

### 6. Step: Your Income

At the end of each period you will see your income screen. The screen has the following structure:




In the first row you see your decision regarding the decision right distribution.
The second row shows, which card position has been recommended (From you or participant B, depending on whether you decided to transfer the decision right or not). The next two lines show which Card position has been chosen and which Card that was. Below, you see your income from that Card.
Last, you see again your chosen search intensity and the associated costs.
Your income from the card minus your search costs then determines your earnings in that period.

After all participants clicked OK, you are randomly matched with another participant B, and a new period starts.
At the end of the experiment, all points that you earned are converted into Swiss Francs. This amount, together with your show up fee, will then be paid to you in cash.

**Control Questions:**

***Please answer the following control questions. Write down all calculations you make. If you have questions, please contact an instructor.***

**1.** You kept the decision right and you chose a search intensity of 80. Your search was successful. Participant B recommended to you to choose the Green Card (position 18). You decided to choose the RED Card.

What are your search costs? …….
What is your final income? …….

**2.** You kept the decision right and you chose a search intensity of 30. Your search was unsuccessful. Participant B recommended to you to choose position 32. You decided to choose position 32. It is the BLUE Card.

What are your search costs? …….
What is your final income? …….

**3.** You kept the decision right and you chose a search intensity of 30. Your search was unsuccessful. Participant B recommended to you to choose position 24. You decided to choose position 28. It is a BLANK.

What are your search costs? …….
What is your final income? …….

**4.** You transferred the decision right and you chose a search intensity of 40. Your search was successful. You recommend position 23 to participant B (the RED card). Participant B chooses position 27. It is the BLUE Card.

What are your search costs? …….
What is your final income? …….

**5.** You transferred the decision right and you chose a search intensity of 40. Your search was successful. You recommend position 7 to participant B (the RED card). Participant B chooses position 7. It is the RED Card.

What are your search costs? …….
What is your final income? …….

# B. APPENDIX TO CHAPTER 2

## *B.1 Instructions Authority Game*

# Instructions for participant A

Welcome to this economic study.

You are now participating in a scientific study, which has been funded by diverse research funds. Please read these instructions carefully. Everything you need to know for participation in the study is explained bellow. If you do not understand something, please contact us. We will answer your question at your cubicle.

At the beginning of the study, you receive a show-up fee of 10 Swiss Francs. During the study you can earn an additional amount of money by collecting points. The number of points you get will depend on your decisions and decisions of other participants.

All the points you earn during the study will be converted to Swiss Francs at the end. The conversion rate is

**15 points = 1 Swiss Franc**

**At the end of the study you will receive the amount of money that you earned during the study as well as the 10 Swiss Francs show-up fee in cash.**

Please note that communication is strictly prohibited during the study. Additionally, you are only allowed to use those functions of your computer that are needed for the study. Communication or playing around with the computer will lead to the exclusion of the study. If you have any questions, don't hesitate to contact us.

This study consists of three parts.

1. The first part runs over 12 periods. In each period you are matched with a different participant B. In each period either you or the matched participant B can implement a project. The detailed instructions for the first part of the study follow below.
2. In the second part of the study, 24 different decisions between a fixed income and a lottery are presented to you. You will receive detailed instructions for the second part of the study once the first part is finished.
3. The third part is very short and you will receive instructions for it on your computer screen.

# Short overview over the first part of the study

In this study, there are two types of participants: participants A and participants B. You are a participant A.

In each of the 12 rounds of this study you are matched with another participant B. In each round, a project can be implemented. Successful implementation of the project leads to positive payments to both participants.

In each round, either you or participant B has the decision right. The participant with decision right can decide, whether variant A or variant B of the project is implemented. In addition, the participant with the decision right can decide on the probability, with which the project will be successful.

The participant with decision right can, therefore, make two decisions:

1. Which variant - A or B - is going to be implemented? At variant A participant A received the larger share of the project payoff, at variant B participant B receives the larger share.
2. What is the probability of project success? This is decided upon by determining a success probability. The determination of the probability is combined with costs for the participant with decision right. The higher the success probability, the higher are the costs.

The payoffs, which result after a successful implementation of the project, vary from round to round. At the beginning of each round you are informed about the payoffs.

If the implementation is not successful, both participants receive 100 point (from an alternative project), independent of whether you or participant B had the decision right. This amount is the same in each round.

You can see an example in the following table:

**Example: Payoffs in one round**

| | | Your payment | Payment participant B |
|---|---|---|---|
| Implementation Successful | **Variant A** | 200 | 150 |
| | **Variant B** | 150 | 200 |
| Implementation unsuccessful | | 100 | 100 |

# Detailed Course of Action

1. **Step: Who holds the decision right?**

**The participant with decision right can choose the project variant and the probability with which the implementation will be successful. At the beginning, you have the decision right. You can**

- o keep the decision right or
- o delegate the decision right to participant B.

1. **Step: Choosing the project variant**

If you keep the decision right, you can determine in step 2, whether variant A or variant B should be implemented.

2. **Step: Choosing the success probability**

Hereupon, you can, if you kept the decision right, choose the probability with which the chosen project variant is successful.

**How is the success probability determined in step 3?**

The participant with the decision right chooses a success probability. He can choose a number between 0 and 100.

| **0 ≤ success probability ≤ 100** |
|---|

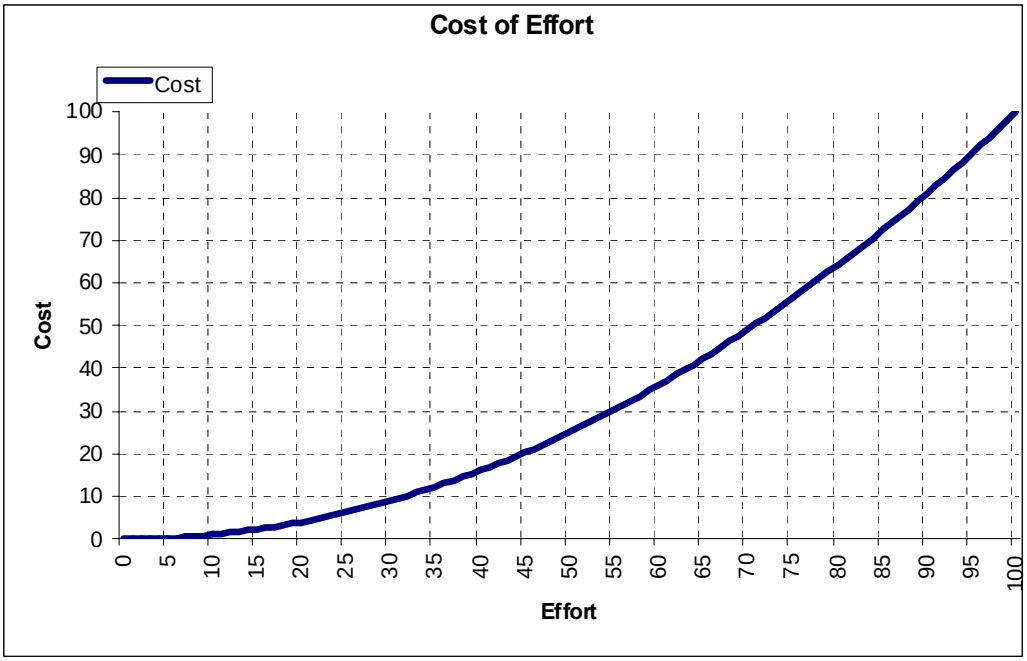
A success probability of 0 means, that the project will never be successful. A success probability of 100 means, that the project will always be successful. For all intermediate values, it can happen that the project is successful or not.

If the project is successful, participant A and participant B will be paid according to the chosen variant. If the project is not successful, both participants receive 100 points (from an alternative project).

**If you delegated the decision right to participant B in step 1, then participant B chooses the project variant in step 2 and the success probability in step 3.**

**The costs of choosing the success probability**

The higher the success probability, that the participant with decision right chooses, the higher are his costs. The following graph shows the costs associated with every possible success probability. Only integers (0,1, 2,…, 99, 100) can be chosen.




You can find an extra sheet on your table. On this extra sheet you can see a table, which reports the costs associated with every selectable success probability. Please adhere to this table when you choose your success probability. You can also choose to display the costs on the computer screen when you choose your success probability.

The following rule always applies: The higher you choose the success probability, the more probable it gets that the project is successful, and the higher will be your costs.

Whether the project is successful or not will be determined by rolling dice.

The participant with decision right is going to throw a red and a white 10-sided die (with numbers from 0-9). The red die determines the first digit, the white die the second digit. This determines a number between 1 and 100 (two nulls count as 100). Each number is equally probable. If the rolled number is smaller or

equal to the chosen success probability, the project is successful. If the rolled number is greater, the project is unsuccessful.

The larger the chosen success probability, the more likely it gets, that the rolled number is smaller than the chosen probability, i. e. that the project is successful.

Examples:

1. You choose a success probability of 15, implying a success probability of 15 percent:

If a smaller or equal number results from rolling the red and the white die, i.e. a number between 1 and 15 (= 15 from 100 possibilities), then the project is successful. If the number is greater than 14 (=16 to 100, i.e. 85 possibilities), then the project is unsuccessful.

2. You choose a success probability of 85, implying a success probability of 85 percent:

If a smaller or equal number results from rolling the red and the white die, i.e. a number between 1 and 85 (=85 from 100 possibilities), then the project is successful. If the number is greater than 84 (=86 to 100, i.e. 15 possibilities), then the project is unsuccessful.

Imagine you roll a 9 with the red die and a 3 with the white die. This implies a number of 93. In this case, the project would be unsuccessful in both cases.

Imagine you roll a 5 with the red die and a 4 with the white die. This implies a number of 54. In this case, the project would be unsuccessful in the first case, but successful in the second case.

Imagine you roll a 0 with the red die and a 3 with the white die. This implies a number of 3. In this case, the project would be successful in both cases.

**The Income**

The income of participant A and participant B is determined by two pieces:

- Payment at the chosen project variant in case of success. If the project implementation is unsuccessful, both participants receive a payment of 100 points from an alternative project.
- The costs associated with the chosen success probability are subtracted from the payoff of the party with decision right.

For you, the following 4 possibilities can occur:

1. You keep the decision right and the project implementation is successful:

**Income: Payment at the chosen project variant minus the costs of the chosen success probability.**

2. You keep the decision right and the project implementation is unsuccessful:

**Income: 100 minus the costs of the chosen success probability.**

3. You delegate the decision right and the project implementation is successful:

**Income: Payment at the project variant chosen by participant B.**

4. You delegate the decision right and the project implementation is successful:

**Income: 100**

**Summary of the course of action in one round**

Initially you, as participant A, have the decision right.

1. You can keep the decision right or delegate it to participant B.

2. The participant with the decision right chooses a project variant.

3. The participant with decision right chooses a success probability.

There are 12 rounds in total. In each round, you are matched with a different participant B. Also, the payments at project variant A and variant B vary from round to round.
At the end of the study, one of the 12 rounds is randomly determined.

For the randomly determined round, the success of the project variant chosen by the participant with the decision right is determined by rolling a die, given the chosen success probability of the participant with the decision right.

Given that you do not know which of the twelve periods is going to be randomly selected, think carefully about all decisions you take in all 12 rounds. The resulting payoffs then determine your payment for the first part of this study.

# Procedure at the computer

## 1. Who holds the decision right?

Initially, you hold the decision right in every round. In every round, you can decide whether you want to delegate the decision right to participant B, or whether you rather want to keep it.

You are not going to make this decision directly, but by choosing a minimal requirement:

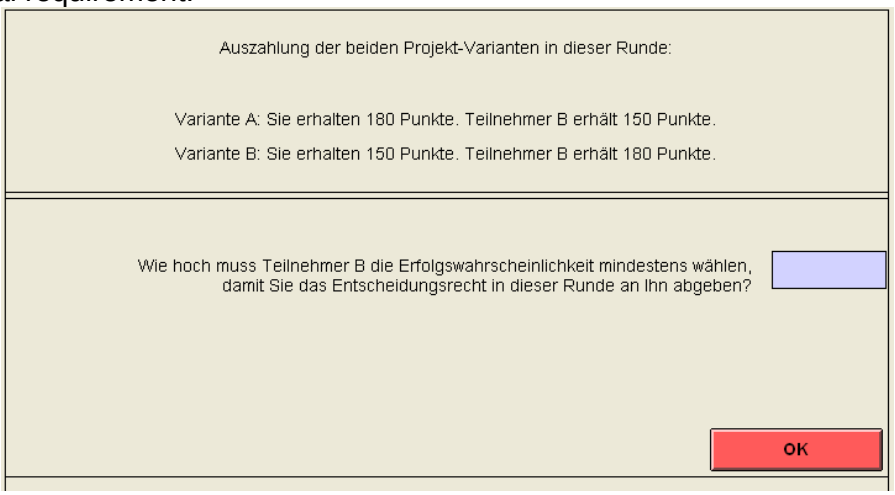
In every period you can decide how high participant B has to choose the success probability, so that you are willing to delegate the decision right to him.

In every period participant B always chooses a success probability for the case that you delegate the decision right to him. When participant B chooses his success probability, he is not informed about your minimal requirement, and is, therefore, choosing his success probability independently of your minimal requirement.

If the success probability of participant B is above your minimal requirement, then the decision right is delegated. If the success probability is below your minimal requirement, you keep the decision right.

You can enter your decision for the minimal requirement on the screen displayed below:

In the upper part of the screen you can always see the payments of both project variants in the given round. In the lower part of the screen you can enter your minimal requirement.

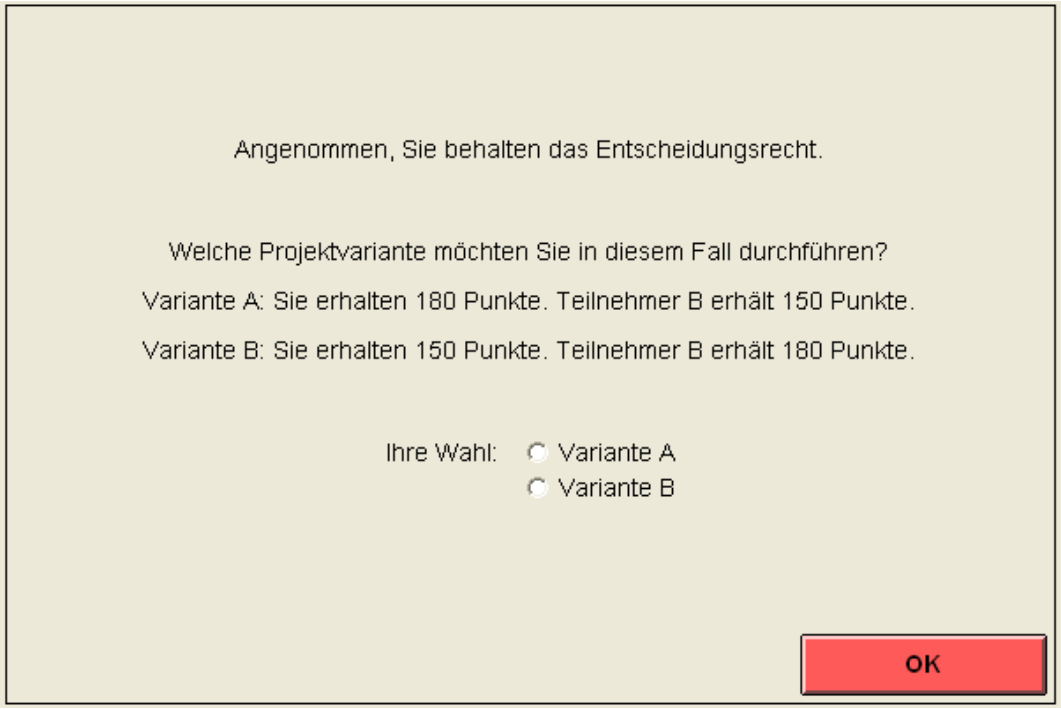



After entering your minimal requirement, click on the OK-button to proceed to the next step.

## 2. Choosing the project variant

When you choose the project variant you don't know whether participant B's success probability has met your minimal requirement or not. Therefore, you have to choose the project variant that you want to implement for the case that you keep the decision right.
The project variant choice is made on the screen displayed below:

In the upper part of the screen you are always informed about the payments of both project variants in the current round. At the bottom of the screen you can choose the project variant.



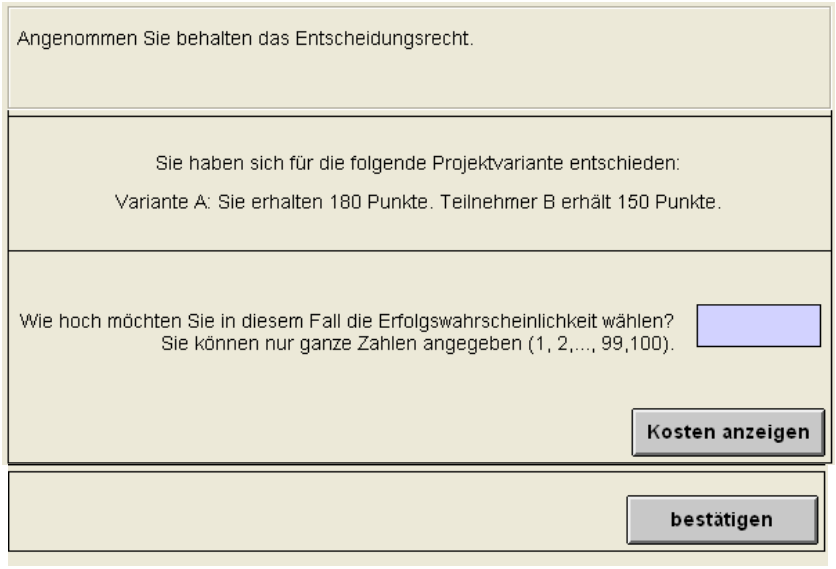

After choosing your project variant, click on OK.

### 3. Step: Choosing the success probability

At the time of choosing the success probability you are still not informed, whether participant B has met your minimal requirement or not. Therefore you have to decide on a success probability in case you keep the decision right. The costs of the success probability only count in case you indeed keep the decision right.

You make the success probability decision on the following screen:

In the upper part of the screen you are still informed about the payoffs of both project variant in the current round. At the bottom of the screen you can enter the success probability you want to choose.



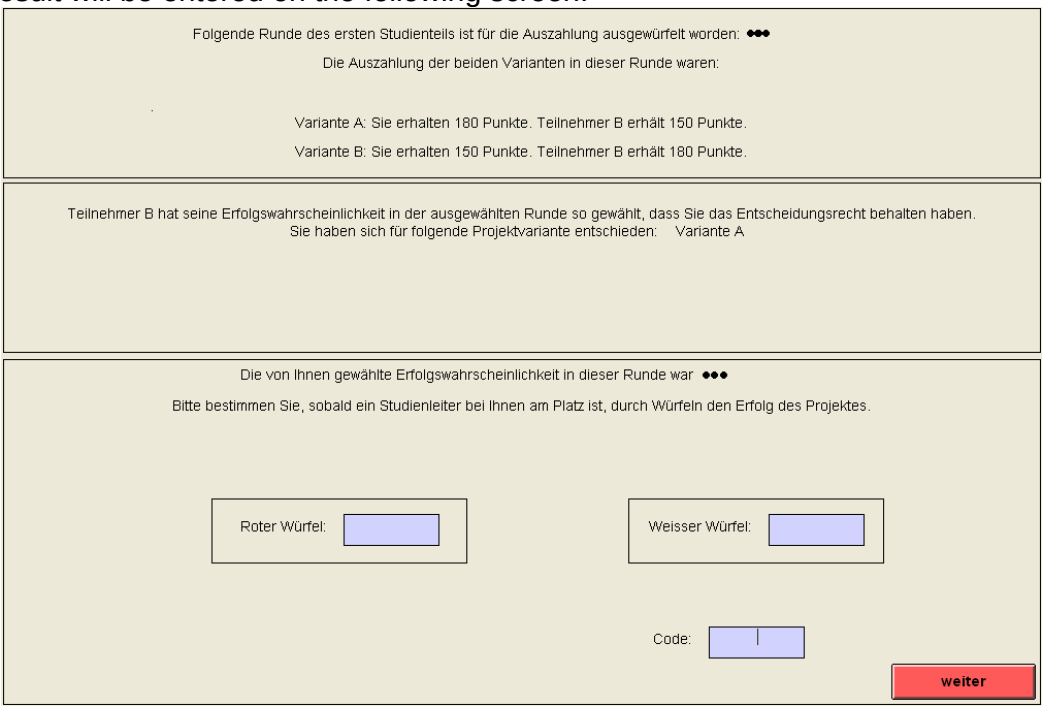

After you chose a success probability, click on the button "show costs". Thereafter, the exact costs associated with the success probability chosen by you are displayed. You can change your success probability, if you wish to. By clicking on "confirm", your decision becomes final.

### 4. Step: Determination of project success

At the very end of the study, after parts 2 and 3, one of the 12 rounds will be randomly determined by rolling a die, and your payments will be determined depending on your choices and the choices of the randomly matched participant B in the chosen round.

1. At first, one round is randomly picked by rolling a 12-sided die.
2. Then, it is checked whether the participant B who was matched with you in the chosen round has chosen a success probability, which is at least as large as your minimal requirement.
   - o If the minimal requirement is fulfilled, you delegate the decision right.
   - o If the minimal requirement is not fulfilled, you keep the decision right.

If you kept the decision right, you determine the project success yourself. This is decided by rolling dice at your place under supervision of an instructor. The result will be entered on the following screen:




You can roll the dice yourself, but the numbers and the code is entered by the instructor.
Do you have any questions regarding the study? Please contact us, and we will answer your questions at your cubicle.

# Control Questions

Please answer the following control questions. If you have questions, please contact an instructor.

1. Imagine that you have chosen a minimal requirement of 51 and participant B has chosen a success probability of 43.
   a) Who has the decision right in this round? .....

You have kept the decision right and chosen a success probability of 54. After that, you roll an 8 with the red die and a 2 with the white die.

   b) How high are your costs?
   c) Was the project implementation successful?

The payments associated with the project were as follows:

| | | Your payment | Payment participant B |
|---|---|---|---|
| Implementation successful | **Variant A** | 200 | 150 |
| | **Variant B** | 150 | 200 |
| Implementation unsuccessful | | 100 | 100 |

Assume you have chosen project variant A.

   d) How high is your income?
   e) How high is the income of participant B?

Assume that you have chosen a success probability of 24 and that you rolled a 1 with the red die and a 5 with the white die. You have again chosen project variant A.

   f) How high would be your costs?
   g) Was the project implementation successful?
   h) How high is your income?
   i) How high is the income of participant B?

2. Imagine that you have chosen a minimal requirement of 39 and participant B has chosen a success probability of 53.

    a) Who has the decision right in this round?\.....

Now assume that you have chosen a minimal requirement of 65 and participant B has chosen a success probability of 54.

    b) Who has the decision right in this round?.....

The payments associated with the project were as follows:

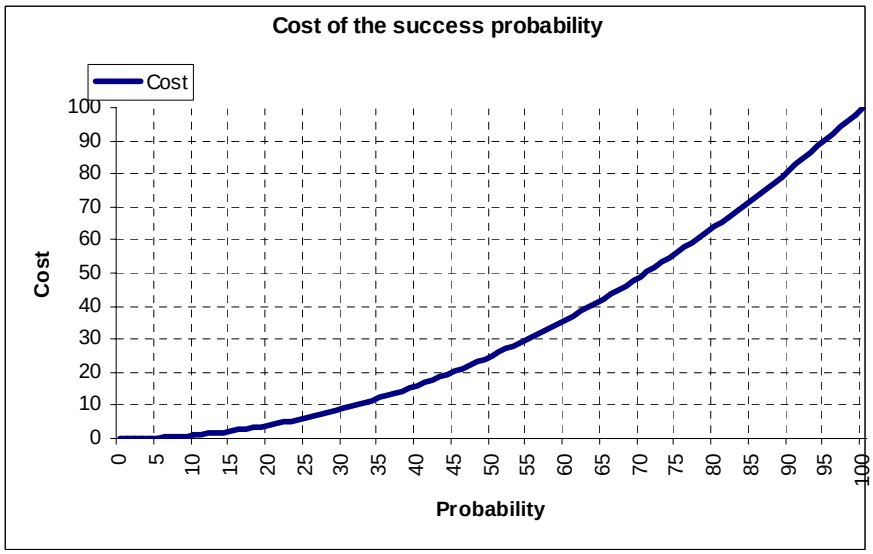
| | | Your payment | Payment participant B |
|---|---|---|---|
| Implementation successful | **Variant A** | 180 | 150 |
| | **Variant B** | 150 | 200 |
| Implementation unsuccessful | | 100 | 180 |

Assume you have delegated the decision right. Participant B has chosen variant B and a success probability of 43, and the project implementation is successful.

    c) How high is your income?
    d) How high is the income of participant B?

Assume you have delegated the decision right. Participant B has chosen variant B and a success probability of 48, and the project implementation is unsuccessful.

    e) How high is your income?
    f) How high is the income of participant B?




| Success Probability | Cost | Success Probability | Cost | Success Probability | Cost | Success Probability | Cost |
|---|---|---|---|---|---|---|---|
| 0 | 0.0 | | | | | | |
| 1 | 0.1 | 26 | 6.8 | 51 | 26.0 | 76 | 57.8 |
| 2 | 0.2 | 27 | 7.3 | 52 | 27.0 | 77 | 59.3 |
| 3 | 0.3 | 28 | 7.8 | 53 | 28.1 | 78 | 60.8 |
| 4 | 0.4 | 29 | 8.4 | 54 | 29.2 | 79 | 62.4 |
| 5 | 0.5 | 30 | 9.0 | 55 | 30.3 | 80 | 64.0 |
| 6 | 0.6 | 31 | 9.6 | 56 | 31.4 | 81 | 65.6 |
| 7 | 0.7 | 32 | 10.2 | 57 | 32.5 | 82 | 67.2 |
| 8 | 0.8 | 33 | 10.9 | 58 | 33.6 | 83 | 68.9 |
| 9 | 0.9 | 34 | 11.6 | 59 | 34.8 | 84 | 70.6 |
| 10 | 1.0 | 35 | 12.3 | 60 | 36.0 | 85 | 72.3 |
| 11 | 1.2 | 36 | 13.0 | 61 | 37.2 | 86 | 74.0 |
| 12 | 1.4 | 37 | 13.7 | 62 | 38.4 | 87 | 75.7 |
| 13 | 1.7 | 38 | 14.4 | 63 | 39.7 | 88 | 77.4 |
| 14 | 2.0 | 39 | 15.2 | 64 | 41.0 | 89 | 79.2 |
| 15 | 2.3 | 40 | 16.0 | 65 | 42.3 | 90 | 81.0 |
| 16 | 2.6 | 41 | 16.8 | 66 | 43.6 | 91 | 82.8 |
| 17 | 2.9 | 42 | 17.6 | 67 | 44.9 | 92 | 84.6 |
| 18 | 3.2 | 43 | 18.5 | 68 | 46.2 | 93 | 86.5 |
| 19 | 3.6 | 44 | 19.4 | 69 | 47.6 | 94 | 88.4 |
| 20 | 4.0 | 45 | 20.3 | 70 | 49.0 | 95 | 90.3 |
| 21 | 4.4 | 46 | 21.2 | 71 | 50.4 | 96 | 92.2 |
| 22 | 4.8 | 47 | 22.1 | 72 | 51.8 | 97 | 94.1 |
| 23 | 5.3 | 48 | 23.0 | 73 | 53.3 | 98 | 96.0 |
| 24 | 5.8 | 49 | 24.0 | 74 | 54.8 | 99 | 98.0 |
| 25 | 6.3 | 50 | 25.0 | 75 | 56.3 | 100 | 100.0 |

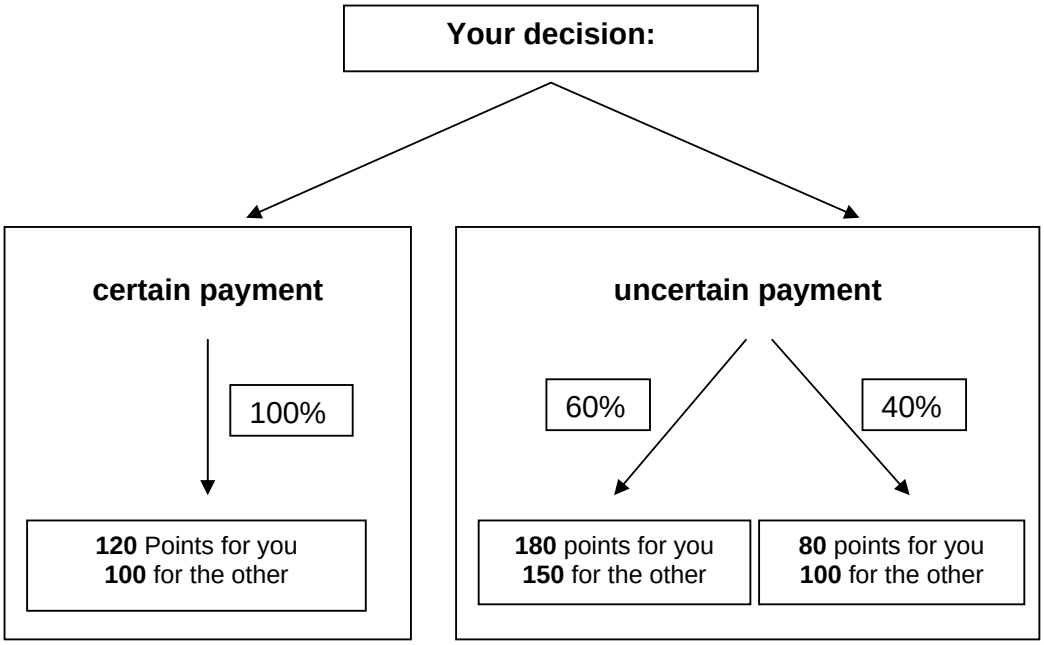
## *B.2 Instructions Lottery Experiment*

# Second Part of today's study

There are 24 rounds in this part of the study. In each round you are randomly matched with another participant. The following rule still applies: 15 points=1 Swiss Franc.

**In each round, you have to decide between a certain payment and an uncertain payment. Your decision also determines the payment for the other, randomly matched participant.**

An Example:



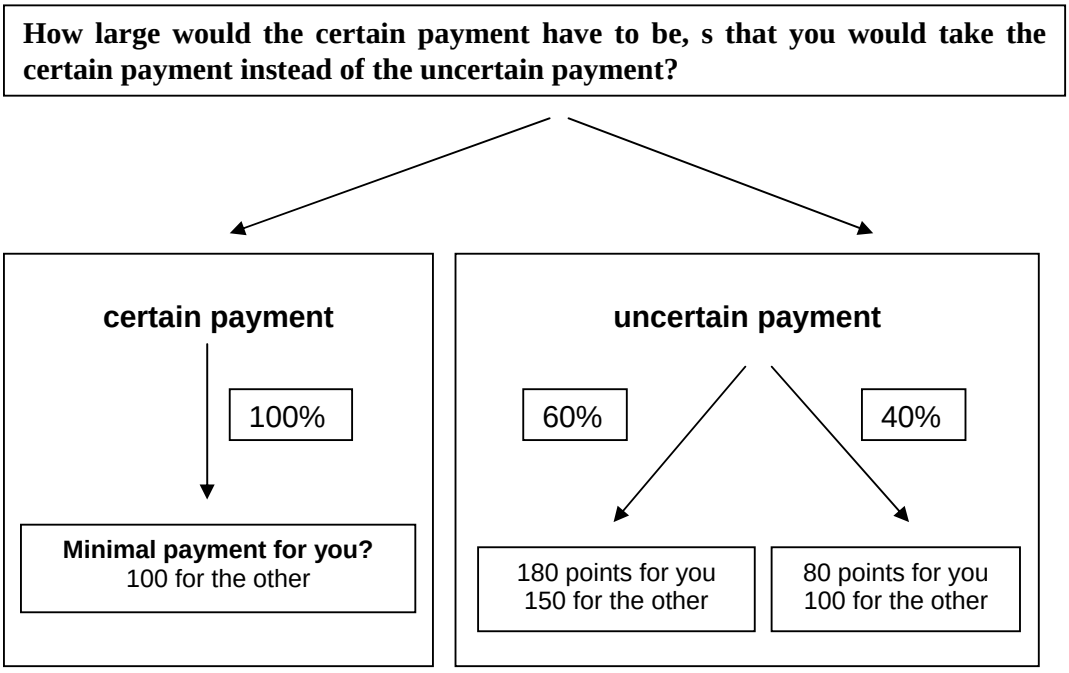

If you choose the **certain payment** in the example above, you receive 120 points and the other randomly matched participant receives 100 points.

If you choose the uncertain payment with 60% probability you receive 180 points and the other participant 150 points. With 40% probability you receive 80 points and the other participant 100 points.

**In each of the 24 rounds you have to make a decision between a certain and an uncertain payment. Payments and probabilities will vary from round to round.**

**How do you make your decision between the certain and the uncertain payment?**

When you make your decision between the certain and the uncertain payment in a given round, you do not yet know the exact size of the certain payment. Therefore, you cannot directly choose between a certain and an uncertain payment, but you have to decide how high the certain payment would have to be, so that you would take the certain payment instead of the uncertain payment.




The certain payment for the other participant is always 100 points. In every round, you are informed about the uncertain payments for you and the other participant as well as the probabilities of these payments.

Only after having decided on the **minimal certain payment required** that you would choose the certain payment, you are informed about the **actual certain**

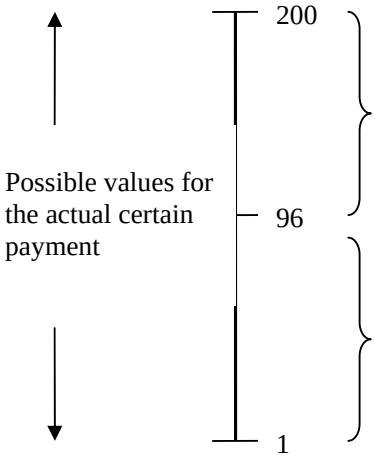
**payment**. Your decision between the certain and the uncertain payment is then implemented as follows:

- If the actual certain payment is smaller than your stated minimal certain payment requirement, your income and the income of the other participant is determined by the uncertain payment.
- If the actual certain payment is larger than your stated minimal certain payment requirement, you receive the actual certain payment and the other participant receives 100 points.

The possible values of the actual certain payments lie between 0 and 200. Every integer value (0,1,2,3,…,200) is equally probable. Your stated minimal certain payment requirement can also be any value between 0 and 200.

The following graph again illustrates the relationship between your stated minimal certain payment requirement, the size of the actual certain payment and your decision between the certain and the uncertain payment

If, for example, you state a minimal certain payment requirement of 96, this implies that every actual certain payment between 96 and 200 is preferred by you to the uncertain payment.
You are only informed about the exact size of the actual certain payment after you have entered your minimal certain payment requirement.




If the actual certain payment is 96 or larger, you receive the actual certain payment. Your income is equal to the actual certain payment in this case. The other participant receives 100 points.

If the actual certain payment is smaller than your stated minimal certain payment requirement of 96, you and the other participant receive the uncertain payment.
The exact size of your payment will then be determined by chance.

**When deciding on your minimal certain payment requirement, you should ask yourself the following questions:**

- Would you prefer a certain payment of 200 points over the uncertain payment? If yes, you should ask yourself:
- Would you prefer a certain payment of 199 points over the uncertain payment? If yes, you should ask yourself:
- Would you prefer a certain payment of 198 points over the uncertain payment? And so on.

Until you reach a certain payment amount, at which you only just prefer the certain payment. In the example above, this amount is 96. This implies, that you only just prefer a certain amount of 96 to the uncertain payment, but if the certain payment would be 95 or less, you would prefer the uncertain payment.

**The Income**

**If your actual certain payment is at least as high as the minimal certain payment requirement that you entered:**

You receive the actual certain payment.
The other participant receives 100 points.

**If your actual certain payment is smaller than the minimal certain payment requirement that you entered:**

Given the probabilities of the given uncertain payments, your payoff and the payoff of the other participant is randomly determined.

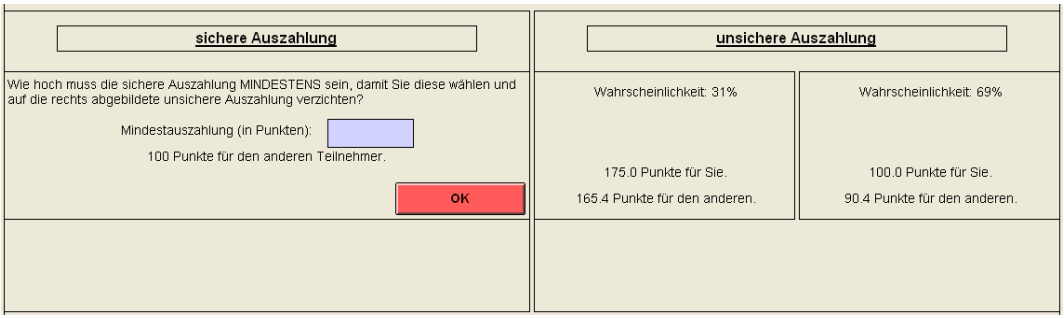
**At the end of the study, 2 of the 24 rounds will be randomly chosen by rolling dice.**

For the two chosen rounds, the actual certain payment will be compared to your minimal certain payment requirement and – if the actual certain payment is below your minimal requirement – it is determined by rolling dice, which of the two uncertain payments you and the other participant receive.

**Since you do not know which of the 24 rounds will be randomly chosen, you should carefully think about your decisions in each of the 24 rounds!**

## Procedures on the Computer

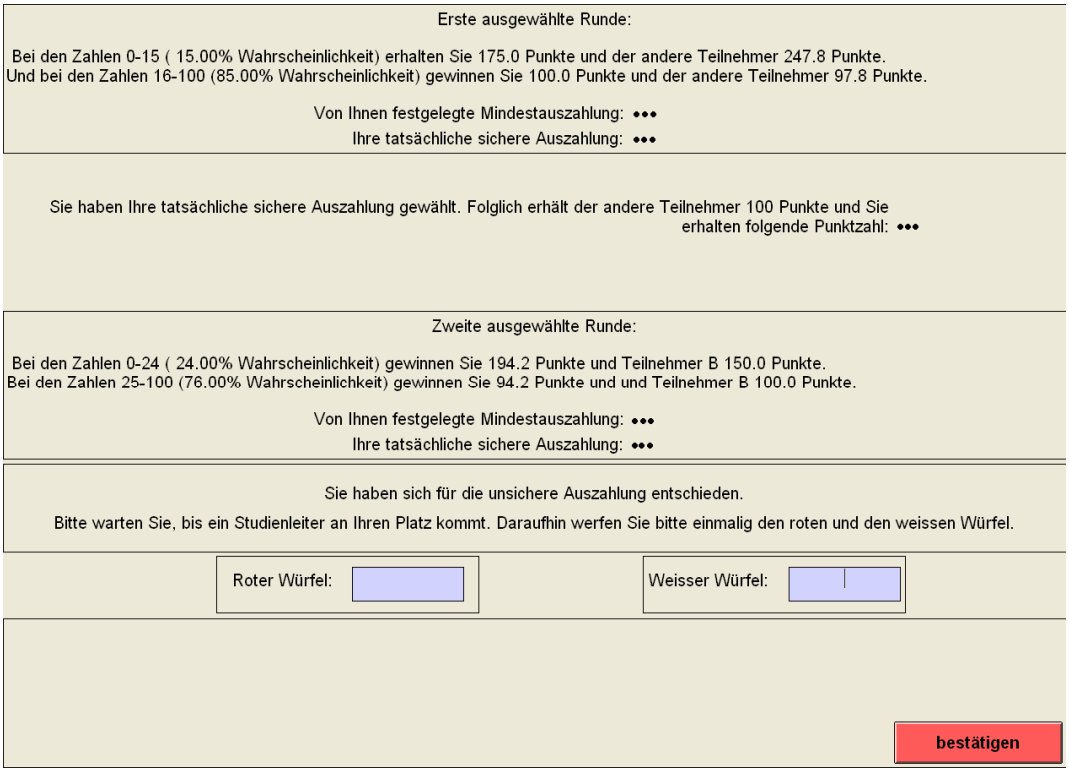
1. Your decision about your **minimal certain payment required that you would prefer the certain payment over the uncertain payment** is entered in each round on the following screen:




On the right side of the screen, you can see the uncertain payments for you and the other, randomly matched participant. You also see the probabilities, with which the potential payment occur. This information will differ from round to round.

On the left side, you can enter your minimal certain payment requirement. Your minimal certain payment requirement determines which certain payment you have to receive at least, so that you would prefer the certain payment over the uncertain payment. After making your decision, please click the OK-button. As long as you have not clicked on the button, you can change your entry.

2. If in one of the two randomly chosen rounds your minimal certain payment requirement is below the actual certain payment, it will be decided by rolling dice which of the two uncertain amounts you and the other participant receive. Rolling dice works the same way as in part 1 of the study. The numbers you rolled will be entered by an instructor on the screen below:

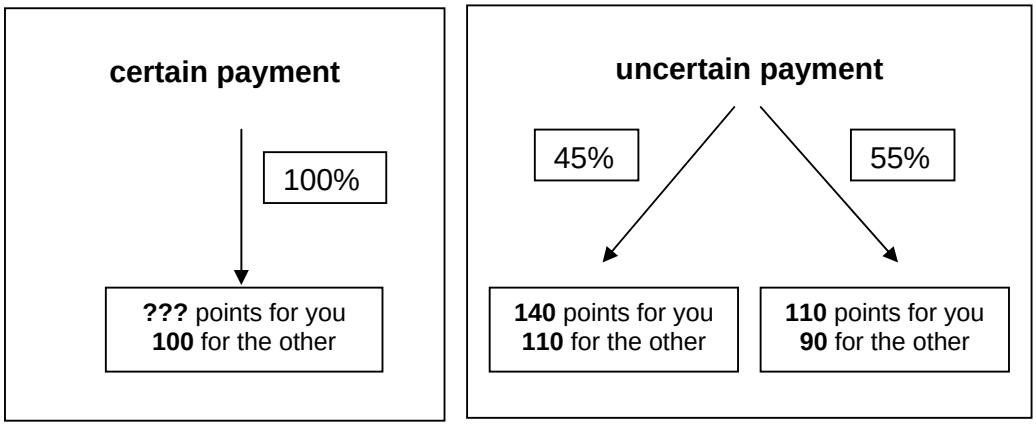



Do you have any questions regarding this study? Please contact an instructor; we will answer your question at your cubicle.

On the next page, you will find a few control questions.

# Control Questions

Assume that the following amounts and probabilities were given for the certain and the uncertain payments in a round.




1. **Assume that you entered a minimal certain payment requirement of 77.**

a) Assume, that the actual certain payment is 113.
What is your payment in this round? …….
What is the payment of the other participant in this round? …….

b) Assume, that the actual certain payment is 61.
What is your payment in this round? …….
What is the payment of the other participant in this round? …….

2. **Assume that you entered a minimal certain payment requirement of 142.**

a) Assume, that the actual certain payment is 113.
What is your payment in this round? …….
What is the payment of the other participant in this round? …….

b) Assume, that the actual certain payment is 61.
What is your payment in this round? …….
What is the payment of the other participant in this round? …….

**3. Assume that you entered a minimal certain payment requirement of 19.**

a) Assume, that the actual certain payment is 113.
What is your payment in this round? …….
What is the payment of the other participant in this round? …….

b) Assume, that the actual certain payment is 61.
What is your payment in this round? …….
What is the payment of the other participant in this round? …….

# C. APPENDIX TO CHAPTER 3

## *C.1 Questionnaires given to the supervisors and the HR department*

*Table C.1:* Taking Charge Questionnaire

| This person often... | |
|---|---|
| 1. | tries to adopt improved procedures for doing his or her job. |
| 2. | tries to change how his or her job is executed in order to be more effective. |
| 3. | tries to bring about improved procedures for the work unit or department. |
| 4. | tries to institute new work methods that are more effective for the company. |
| 5. | tries to change organizational rules or policies that are nonproductive or counterproductive. |
| 6. | makes constructive suggestions for improving how things operate within the organization. |
| 7. | tries to correct a faulty procedure or practice. |
| 8. | tries to eliminate redundant or unnecessary procedures. |
| 9. | tries to implement solutions to pressing organizational problems. |
| 10. | tries to introduce new structures, technologies, or approaches to improve efficiency. |

This questionnaire is adopted from Morrison and Phelps (1999)

*Table C.2:* Performance Questionnaire

| | |
|---|---|
| 1. | He/she has usually exceeded the required performance. |
| 2. | Compared to colleagues with similar job profile and tenure, he/she excels in task achievement. |
| 3. | Concerning his field of activity, he/she possesses extraordinary skills. |
| 4. | He/she possesses an extraordinary work and achievement motivation. |

*Table C.3:* Action Orientation Questionnaire

| | |
|---|---|
| 1. | The employee's time management does not enable him/her to complete his/her tasks on time. |
| 2. | The employee does not hesitate to implement decisions. |
| 3. | The thorough analysis of a task paralyses his/her actions. |
| 4. | Even if he/she is working on an urgent task, he/she tends to interrupt it to do something else in between. |
| 5. | If multitasking is necessary, he/she has difficulties organizing everything effectively. |
| 6. | If he/she has to complete an unpleasing task, he/she likes to procrastinate. |
| 7. | Whatever he/she puts on a day's schedule is finished in the evening. |
| 8. | If he/she has to complete too many tasks at once, he/she has problems deciding which one to start with. |
| 9. | It is easy for him/her, to adhere to his/her priorities at work. |

This questionnaire is adopted from Hossiep and Paschen (2003)

*Table C.4:* Gestalt Motivation Questionnaire

| | |
|---|---|
| 1. | If I delegate a task to him/her, he/she does anything to fully implement it. |
| 2. | If he/she has set a goal, he/she consequently strives for it |
| 3. | If he/she undertakes something, he/she will only be satisfied if he/she accomplishes it. |
| 4. | If things go wrong, he/she increases his/her effort even more. |
| 5. | He/she is inclined to work hard and persistently. |
| 6. | He/she approaches problems in an active way. |
| 7. | If something goes wrong, he/she immediately looks for solutions. |
| 8. | If possibilities arise to shape something, he/she exploits them. |
| 9. | He/she immediately takes the initiative, if no one else does it. |
| 10. | He/she quickly avails him/herself of opportunities to achieve his/her goals. |
| 11. | He/she usually does more than required from him/her. |
| 12. | He/she is particularly good in implementing ideas. |

This questionnaire is adopted from Hossiep and Paschen (2003)

*Table C.5:* Creativity Questionnaire

| | |
|---|---|
| 1. | The employee has the ability to quickly find usable solutions for novel problems. |
| 2. | The employee has extraordinary ideas that help advancing the project. |
| 3. | The employee has the ability to create something completely new out of existing things. |
| 4. | The employee looks for solutions outside of ordinary patterns. |

## *C.2 Instructions*

You are now taking part in a scientific study. A research foundation has provided funds for this research. Please read the following instructions carefully. Everything that you need to know in order to participate in this experiment is explained below. Should you have any difficulties in understanding these instructions please notify us. We will answer your questions at your cubicle.

During the course of the experiment you can earn Taler. The amount that you earn during the experiment depends on your decisions. All the gains that you make during the course of the experiment will be exchanged into cash at the end of the experiment.

The exchange rate will be:
75 Taler = 1 CHF

At the end of the study, you will receive your earned amount in cash.

Please note that communication between participants is strictly prohibited during the experiment. In addition we would like to point out that you may only use the computer functions which are required for the experiment. In case you have any questions dont hesitate to ask us. An instructor will answer your questions at your cubicle.

**Detailed procedures of the first part of the study**

In this part of the study, you will take on the role of an individual running an ice cream stand. There will be 20 periods in which you will have to make decisions on how to run the business in order to maximize profit. These decisions will involve the location of the stand, the flavour of the ice cream, the sugar and flavour content, and the ice cream color and price. You can freely choose all these variables. Your goal is to chose them such that you achieve maximal profit. At the end

of each period, you will learn what profits you made during that period. You will also hear some customer reactions that may help you with your choices in the following periods. The decisions you make in one period, will be the default choices for the next period.

**Previous Manager Guidelines**

Dear X,

I have enclosed the following guidelines that you may find helpful in running your lemonade stand. These guidelines are based on my previous experience running this stand. When running my business, I followed these basic guidelines:

- Location: Business District
- Sugar Content: 3%
- Lemon Content: 7%
- Ice Color: soft
- Price: 8.2 Taler
- Flavour: Orange

With these choices, I was able to make an average profit of about 90 Taler per period. I have experimented with alternative choices of sugar and lemon content, as well as lemonade color and price. The above choices were the ones I found to be the best. I have not experimented with alternative choices of location though. They may require very different strategies.

There is another ice cream stand in town which is famous for his chocolate-, vanilla-, straciatella- and strawberry icecream. It makes no sense to sell these flavours. Otherwise it is known that the demand for ice cream flavours is typical for the German speaking area. I also know that the flavour has no impact on the

optimal price, color, flavour intensity or sugar content.

Regards,
Previous Manager

**Payment**

Your compensation will be based on the profits you make with your lemonade stand. You will get paid your own ice cream stand profits in the last 10 periods of the experiment. The profit achieved in periods 1-10 is not relevant for your own payment.

Example:
If your income in periods 11-20 was 3000 Taler, you will receive 40 CHF at the end of the study in cash.

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